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Minerals

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Lisbon
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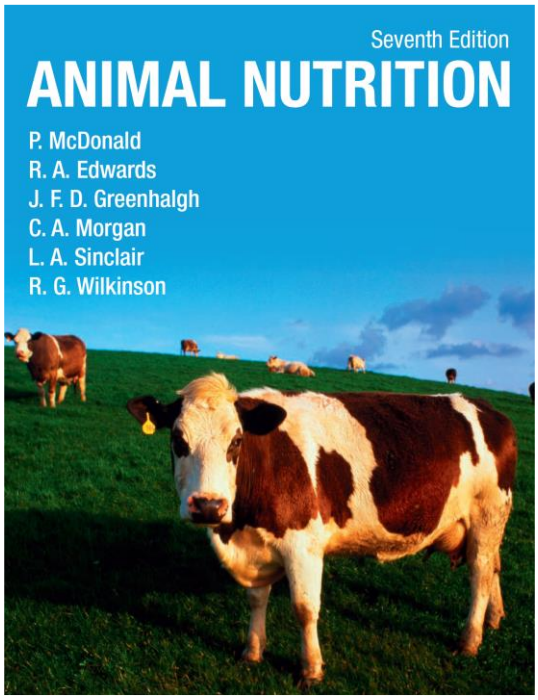
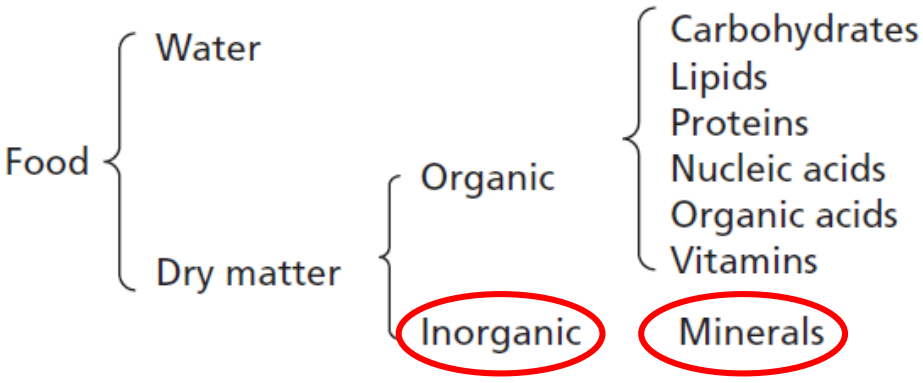


Chapter 6

Objectives

- To obtain information on the minerals of importance to domestic animal biology and nutrition
- **Differentiate Major and Trace elements**
- To know the biological roles of each mineral and their association
- To know the effects of mineral deficiencies and how to deal with them

A mineral is a substance such as tin, salt, or sulphur that is formed naturally in rocks and in the earth. Minerals are also found in small quantities in food and drink.



(Animal Nutrition – McDonald et al)

Introduction

- Most of the naturally occurring mineral elements are found in animal tissues
- Many are present because they are constituents of the animal's food and do not have an essential function in the animal's metabolism
- **Essential** mineral element → a mineral element that has been **proven to have a metabolic role in the body**
- **1950→ 13 mineral** elements were classified as essential: these comprised the major elements (calcium, phosphorus, potassium, sodium, chlorine, sulphur, magnesium) and the micro or trace elements (iron, iodine, copper, manganese, zinc and cobalt)
- **1970** → molybdenum, selenium, chromium and fluorine added to the list
- *More recently: arsenic, boron, lead, lithium, nickel, silicon, tin, vanadium, rubidium and aluminium*

Introduction

- They may be acquired from the environment
- It has been suggested that as many as 40 or more elements may have metabolic roles in mammalian tissues
- Many are **required in such minute quantities**, or are so widely distributed in foods for animals, that deficiencies are likely to be extremely rare under normal practical conditions
- Essential minerals into Major elements and Trace elements
- Normally trace elements are present in the animal body in a concentration not greater than **50 mg/kg** and are required at less than **100 mg/kg diet**

Major and Trace elements

Table 6.1 Nutritionally important essential mineral elements and their approximate concentration in the animal

Major elements	g/kg	Trace elements	mg/kg
Calcium	15	Iron	20–80
Phosphorus	10	Zinc	10–50
Potassium	2	Copper	1–5
Sodium	1.6	Molybdenum	1–4
Chlorine	1.1	Selenium	1–2
Sulphur	1.5	Iodine	0.3–0.6
Magnesium	0.4	Manganese	0.2–0.5
		Cobalt	0.02–0.1

(Animal Nutrition – McDonald et al)

Introduction

- Minerals are held in different forms in the body, which can be considered as compartments
  - Central reserve (plasma, skeleton, etc.)

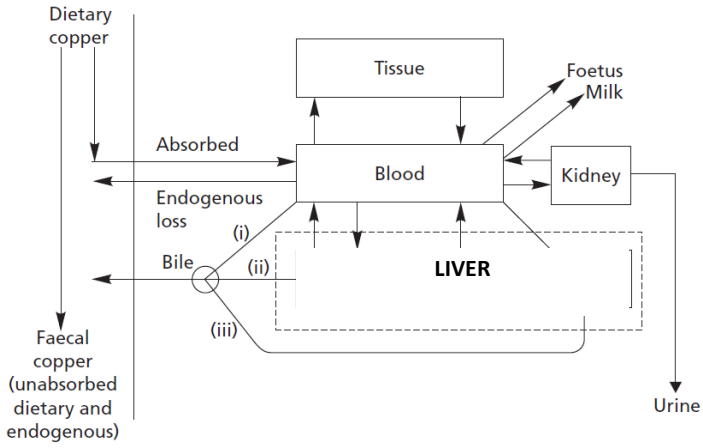


Fig. 6.1 Diagram of the possible routes of movement of copper in the ruminant

(Animal Nutrition – McDonald et al)

Mineral Roles

- Nearly all the essential mineral elements, both major and trace, are believed to have one or more catalytic functions in the cell
- **Physiological Role:** Sodium, Potassium and Chlorine have primarily an electrochemical or physiological function and are concerned with the maintenance of acid–base balance, membrane permeability and the osmotic control of water distribution within the body
- **Structural Role:** Calcium and Phosphorus are essential components of the skeleton and Sulphur is necessary for the synthesis of structural proteins
- **Regulatory function:** Controlling cell replication and differentiation → Zn
- **Unique functions**: Fe → Respiration, Co → vitamin B12

Mineral toxicity

- Many are toxic – causing illness or death – if given to the animal in excessive quantities
- True of copper, selenium, molybdenum, fluorine, vanadium and arsenic
- Copper and Fluorine are cumulative poisons
- Supplementation of any diet with minerals should always be carried out with great care, and the indiscriminate use of trace elements must be avoided
- Supplement should be tailored to the target animal
- **Minerals should be added to concentrate foods via a premix and thoroughly mixed**

Natural and supplementary sources of minerals

- **Plants and plant products** form the main supply of nutrients to animals
  - species and stage of maturity of the plant
  - type of soil and climate
  - seasonal conditions
  - Legumes tend to be richer in the major minerals and certain trace elements than are grasses
- **Animal products** used in animal feeding, fishmeal, whey and skimmed milk, are good sources of the major minerals
- **Inorganic** limestone for calcium, dicalcium phosphate for phosphorus, common salt for sodium, and calcined magnesite for magnesium
- **Diets for farm animals contain a mineral/trace element/vitamin supplement and, on occasions, it is necessary to include extra supplies of some minerals, e.g. calcium for laying hens**

Lembrar as aulas de Alimentação Animal!!!!!

Major elements

Calcium

- Most abundant mineral element in the animal body
- Important constituent of the skeleton and teeth
- Roles:
  - transmission of nerve impulses
  - contractile properties of muscle
  - coagulation of blood

Calcium in bone

- Skeleton is not a stable unit in the chemical sense
- large amounts of the calcium and phosphorus in bone can be liberated by reabsorption → Milk and egg production
- Resorption of calcium is controlled by the action of the parathyroid gland → Parathyroid hormone
  - Animals are fed on a low-calcium diet → calcium concentration in blood decreases → parathyroid gland is stimulated → resorption of Ca from bone
- Parathyroid hormone → regulating the amount of the calcium absorbed from the intestine and urinary calcium resorption at the kidney

Calcium sources

- Milk and dairy by-products
- Green leafy crops, especially legumes, and sugar beet pulp
  - Not cereals
- Animal by-products containing bone → fishmeal
- Ground limestone, steamed bone flour and dicalcium phosphate

Ca: Deficiency symptoms

- Young growing animals: Rickets, misshapen bones, enlargement of the joints, lameness and stiffness
- Adults: osteomalacia (Ca in bone is withdrawn and not replaced) → Broken bones, etc.
- Hens: soft beak and bones
- Dairy cows: Milk fever (parturient paresis)

Milk Fever (MF)

- Known as parturient paresis
- Occurs in mature cows within 48h after calving
- Low blood calcium, lack of muscle strength and contractility
- Calcium intake is not sufficient for high milk production and starts depleting bone reserves
- Older animals and Jerseys are more susceptible

MF – Symptoms and treatment

- Hind limb stiffness
- Partial paralysis
- Unable to rise
- Poor appetite
- Dry muzzle
- Reduced rumen movement
- Slow respiration
- Low body temperature and cold ears
- **Treatment: Calcium salts I.V.**

MF - Prevention

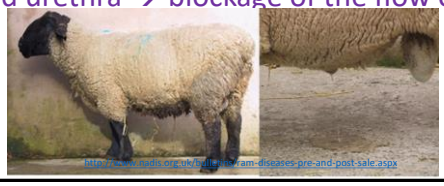
- Avoid excessive calcium intake during the dry period
- Low dietary calcium in the dry period will condition the cow to draw calcium from bone

Phosphorus

- More known functions than any other mineral element
- Association of phosphorus with calcium in **bone** → Ca/P 2/1
- Occurs in **phosphoproteins, nucleic acids and phospholipids**
- vital role in **energy metabolism** in the formation of sugar-phosphates and ADP/ATP (metabolism classes)

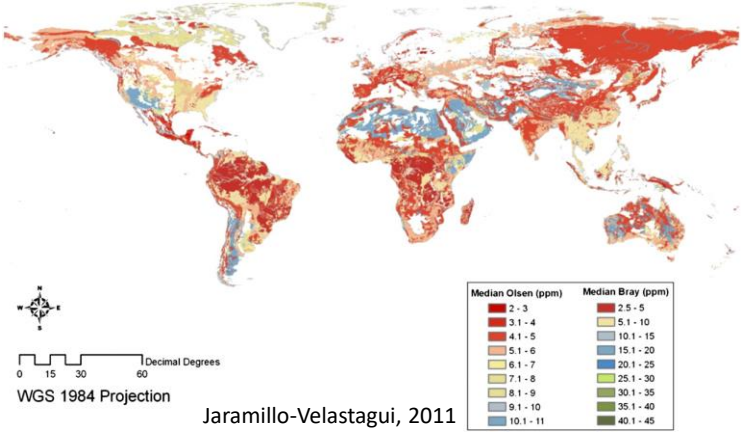
Phosphorus: sources

- Milk, cereal grains and fishmeal products containing bone
- Content in hays and straws is generally very low
- Much of the element present in cereal grains is in the form of phytates, which are salts of phytic acid
  - Phosphorus of calcium phytate is utilised only 10 per cent as effectively as disodium phosphate
- Feeding with high levels of phosphorus:
  - Excretion → Pollution → Algae blooms
  - Formation of mineral deposits in the bladder and urethra → blockage of the flow of urine in male sheep and cattle



Phosphorus: Deficiency symptoms

- Extensive areas of phosphorus-deficient soils occur throughout the world → tropics → Affects grazing livestock



Jaramillo-Velastagui, 2011

Symptoms:

1. Rickets
2. Osteomalacia
3. **Pica, or depraved apetite → chew bones**
4. Poor fertility
5. Irregularity of oestrus
6. Lower production milk and eggs
7. Growth retardation
8. More severe in cattle than in sheep

FIGURE 2.—Lamb fed a ration deficient in phosphorus. Note the knock-kneed conformation. (From Idaho Agricultural Experiment Station.)

https://projects.ncsu.edu/project/swine_extension/nutrition/nutritionslides/48.jpg

https://commons.wikimedia.org/wiki/File:Bull_chewing_bone_6.jpg

Pica in Southern Africa

https://www.namibian.com.na/index.php?id=124582&type=2

Potassium

- Potassium plays a very important part, along with sodium, chlorine in osmotic regulation of the body fluids and in the acid–base balance
- Plays an important part in nerve and muscle excitability
- Involved in **carbohydrate metabolism**
- Deficiency:
  - **Potassium content of plants is very high → rare deficiency in grazing animals**
  - Distiller's grains → deficient in several soluble elements, including potassium
  - Brazil, Panama and Uganda → areas low in K
  - Interfere with the absorption and metabolism of magnesium → hypomagnesaemic tetany
  - Dietary excess of potassium → excreted rapidly in urine

Sodium

- Present in the soft tissues and body fluids
- Concerned with the acid–base balance and osmotic regulation of the body fluids
- Transmission of nerve impulses
- Absorption of sugars and amino acids from the digestive tract
- Ingested in the form of sodium chloride (common salt)

Sodium deficiencies

- Occurs in many parts of the world → especially in the tropical areas of Africa and the arid inland areas of Australia
- Sodium def → lowering of the osmotic pressure → dehydration

Sodium sources

- foods of vegetable origin → low sodium contents
- Animal products, especially fishmeal → richer sources
- Sodium chloride

Chlorine

- Associated with sodium and potassium in acid–base relationships and osmotic regulation
- Plays an important part in the gastric secretion, where it occurs as hydrochloric acid
- Sources: fishmeal and salt

Unless salt is available, deficiencies are likely to occur in both cattle and sheep
Salt def: decreased appetite, weight loss, lowered milk production, cannibalism in hens

https://fertilefields.co.nz/drupal/himalayan_salt_lick

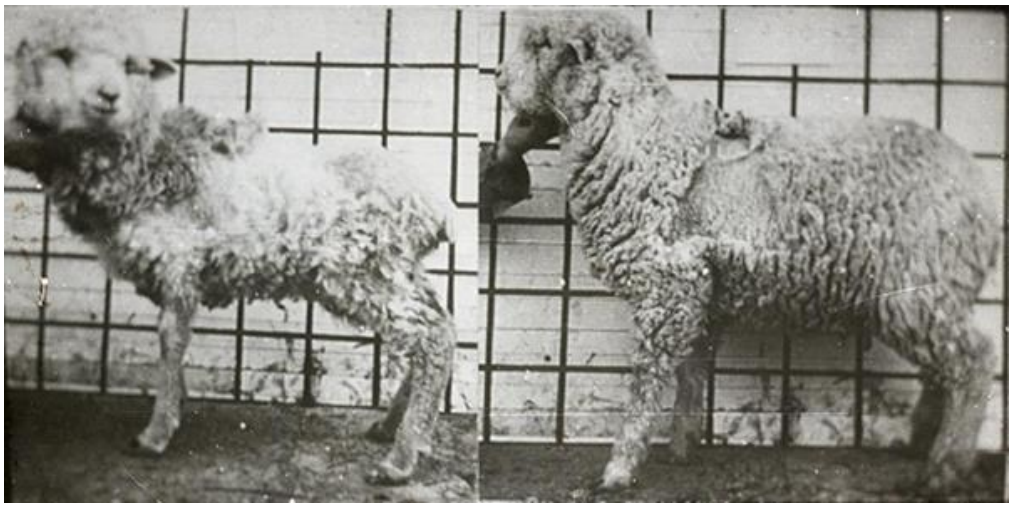
Excess Salt → thirst and dehydration
Chicks and turkey poults very sensitive

https://unitedsalt.com/agricultural/

Sulphur

- Occurs in proteins containing the amino acids cystine, cysteine and methionine
- Component of cartilage, bone, tendons and the walls of blood vessels
- Important in elements of the respiratory process
- **Wool is rich in cystine and contains about 4 per cent of Sulphur**
- Associated with proteins in the feed → problem when protein is replaced by urea

Sulphur deficiency in wool



https://www.asas.org/taking-stock/blog-post/taking-stock/2012/10/10/photo-of-the-week-sulfur-deficiency-in-lambs

Magnesium

- Associated with calcium and phosphorus
- 70 % in skeleton; 30% fluids and soft tissues
- **Enzyme activator**
- Efficient metabolism of carbohydrates and lipids
- Cellular respiration and many other cellular reactions
- **Key element in cellular biochemistry and function**
- Absorbed from the small and large intestine of monogastrics

Sources of Magnesium

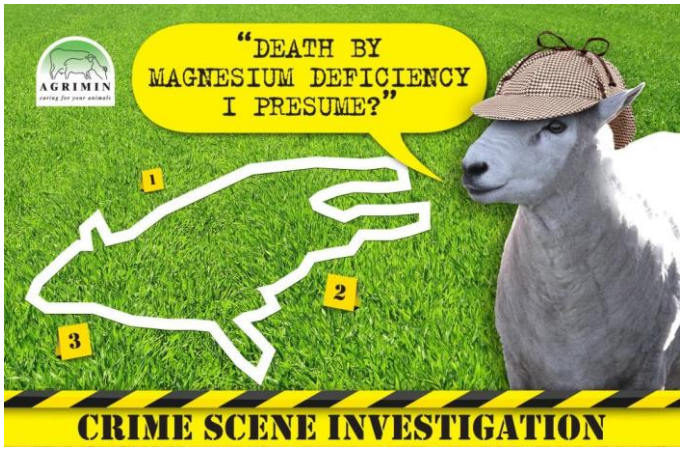
- Wheat bran
- Dried yeast
- Most vegetable protein concentrates (cotton meal)
- Clovers

Magnesium deficiency

- Nervous irritability and convulsions
- Depleted bone magnesium, tetany and death
- Associated to low colostrum intakes
- **Hypomagnesaemia / tetany: with low blood levels of magnesium**

Grass Tetany

- Caused by inadequate blood magnesium levels
- Potentially fatal
- Most common in lactating animals grazing on rapidly growing lush pastures during the beginning of pasture season



Grass Tetany - Symptoms

- Stiff movement
- Loss of appetite
- Frequent urination
- Convulsions
- Major cause: grazing lush, spring pastures with wheat or rye with low levels of magnesium and high levels of potassium

Grass Tetany – Treatment and Prevention

- Treatment
  - Inject magnesium sulphate under the **skin**
- Prevention
  - Provide adequate magnesium daily during the high risk period
  - **Use mineral blocks and provide balanced diet**
  - **Use legumes in pastures (high Magnesium content than cereals)**

Trace elements

Iron

- 90% → combined with proteins (eg haemoglobin)
- also occurs in blood serum in a protein called transferrin → Iron transfer
- Spleen, liver, kidney and bone marrow → Associated to Ferritin (Iron accumulation)
- Major role in numerous biochemical reactions → connection with enzymes

Iron

- Deficiencies:
  - Normal situation: Red blood cells die but haemoglobin is recycled → Iron daily requirements are low
  - Prolonged haemorrhage or during pregnancy → Iron def → Anemia
  - Iron content of milk is usually very low → iron deficiency common in rapidly growing sucklings (e.g. piglets)
    - Anaemia in piglets is characterised by poor appetite and growth.
  - Iron-deficiency anaemia sometimes occur in laying hens
    - egg production drains the body reserves

(Uniferon)

Iron

- Sources:
  - Widely distributed in foods
  - Green leafy materials
  - Legumes
  - Bloodmeal
  - Fishmeal

- Iron toxicity:
  - not a common problem in farm animals
  - can result from prolonged oral administration of the element
  - Oxidative stress
  - **results in alimentary disturbances, reduced growth and phosphorus deficiency**

Copper

- Necessary for haemoglobin formation → Iron metabolism
- Deficiency of copper → disruption of iron metabolism
- Component of superoxide dismutase → antioxidant system
- Reduce the susceptibility to infection in lambs
- Occurs in certain pigments in feathers
- Necessary for the normal pigmentation of hair, fur and wool

- Sources:
  - widely distributed in foods
  - Related to some extent to the soil copper level
  - Seeds and seed by-products are usually rich in copper
  - Copper content of milk is low

Copper Deficiency and Copper Poisoning

- **Copper deficiency** is common when sheep graze pastures low in copper but more often high in iron
- Signs: Hind leg weakness, poor wool quality, anaemia and poor bone mineralization
- Copper is usually given by injection as copper heptonate.
- Supplementation with copper oxide
- Copper poisoning – excess of copper in the diet
  - Breeds are less sensible than others
  - E.g. North Ronaldsay

http://www.nadis.org.uk/bulletins/trace-element-deficiencies-in-sheep.aspx

North Ronaldsay Island (Scotland)

North Ronaldsay Sheep are particularly susceptible to Copper toxicity

Beef cattle with Copper deficiency

http://www.nadis.org.uk/disease-a-z/cattle/trace-element-deficiency-in-cattle/

Copper deficient rabbit and a normal litter-mate. One was maintained on a copper deficient synthetic diet while the other was fed a stock diet. Note the achromotrichia and alopecia

Copper deficiency in the sheep. This deficiency produces a marked decrease in the rate of woold growth and a depigmentation of black wool. "Steely" wool is characterized by limp, glossy fibers lacking the normal crimp.

https://projects.ncsu.edu/project/swine_extension/nutrition/nutritionslides/55.jpg

Cobalt

- Associated to vitamin B12 → is required by microorganisms in the rumen for the synthesis of vitamin B12
- Ruminants have a higher requirement
- Most foods contain traces of cobalt → Use salt licks

Lambs of the same age and fed on diets differing only in cobalt content. The lamb on the left received a diet containing less than 0.07 mg Co/kg. (Reproduced by permission of the Rowett Research Institute, Aberdeen.)

Source: McDonald, Edwards and Greenhalgh (1988). Animal Nutrition 4th Edition. Longman Scientific

Cobalt deficiency

- Cobalt has an important biological role as a constituent of vitamin B12
- Cobalt deficiency occurs where there are low soil cobalt concentrations
- Complicated by parasitic gastroenteritis
- Commonly observed in weaned lambs at pasture during late summer/fall
- Signs: lethargy, reduced appetite, poor quality wool with an open fleece, small size and poor body condition

http://www.nadis.org.uk/bulletins/trace-element-deficiencies-in-sheep.aspx

Cobalt deficiency

- Treatment:
  - Combination of intramuscular injection of vitamin B12
  - Drenching with up to 1 mg/kg bodyweight of cobalt sulphate
- Cobalt containing boluses, which lodge in the reticulum, provide a continuous supply of cobalt but are expensive in those lambs which require supplementation for only two to three months.

http://www.nadis.org.uk/bulletins/trace-element-deficiencies-in-sheep.aspx

Iodine

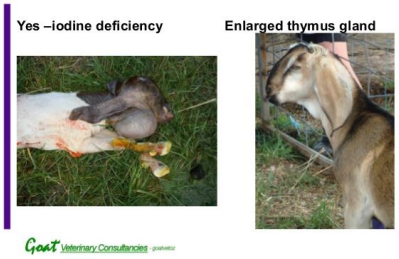
- Concentration is very small
- Involved in the synthesis of T3 and T4 → Thyroid hormones
- Thyroid hormones → increase metabolic rate → accelerates growth and increase oxygen consumption
- Control the development of the foetus
- Involved in immune defense
- Digestion
- Muscle function
- Seasonality of reproduction

- Sources:
  - Foods of marine origin
  - Seaweeds
  - Fishmeal

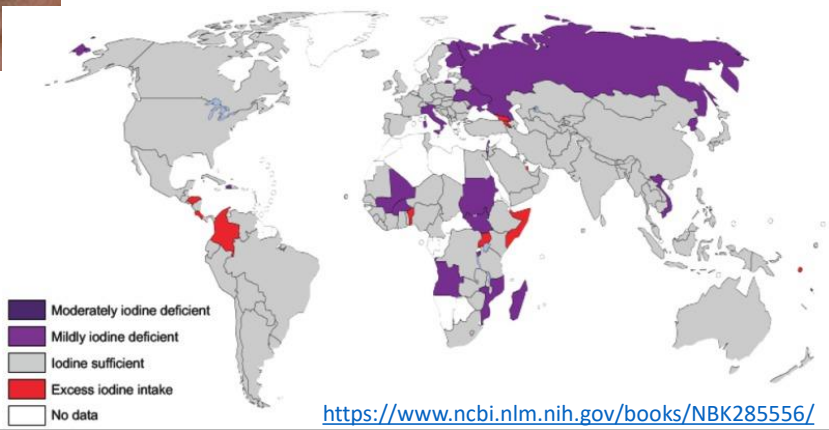
Mineral deficiencies - Iodine

- Leads to goiter (enlarged thyroid = *Bócio*)
- Kids whose dams are Iodine deficient also have goiter
- Commercial feeds and minerals contain non-iodized salt
- Consider offering iodized salt if necessary

Goitre



http://www.edokita.com/goitre-causes-symptoms-and-treatment/



https://www.ncbi.nlm.nih.gov/books/NBK285556/

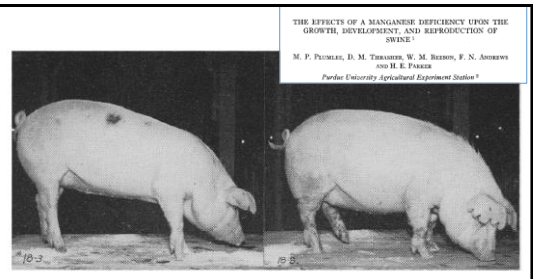
Wild goats eating Kelp (Alaska)

Manganese

- Amount of manganese present in the animal body is extremely small
- Mostly occurs in bones, liver, kidney, pancreas and pituitary gland
- Importance in the animal body:
  - Activator/Constituent of many enzymes
- Sources:
  - Widely distributed in foods
  - Pasture herbages vary considerably
  - Seeds → contain moderate amounts
    - Maize is very low
  - Rice bran and wheat offals → Good source
  - Green plants → Good source

Manganese

- Deficiencies:
  - Found in ruminants, pigs and poultry: retarded growth, skeletal abnormalities and reproductive failure
  - Reduces hatchability and shell thickness in birds
  - Lameness in pigs



THE EFFECTS OF A MANGANESE DEFICIENCY UPON THE GROWTH, DEVELOPMENT, AND REPRODUCTION OF SWINE[1]

M. P. Plumlee, D. M. Tribasher, W. M. Beeson, F. N. Andrews and H. E. Parker

Purdue University Agricultural Experiment Station[2]

Figure 1. Gilt 18–3, left (40.0 p.p.m. Mn), weight 164 lb., age 132 days. Gilt 18–8, right (0.5 p.p.m. Mn), weight 174 lb., age 132 days a littermate to gilt 18–3. Note excessive fatness.

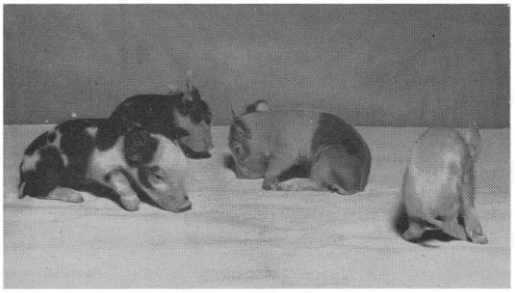


Figure 2. Litter 6 from sow 19–3 (0.5 p.p.m. Mn) showing weakness and poor sense of balance at birth.

Plumlee et al. (1956)

http://www.thepoultrysite.com/publications/6/diseases-of-poultry/220/slipped-tendon-perosis/

Perosis or chondrodystrophy is encountered in young birds whose diet is deficient in manganese (Mn) or some of the following vitamins: choline, nicotic acid, pyridoxine, biotin or folic acid

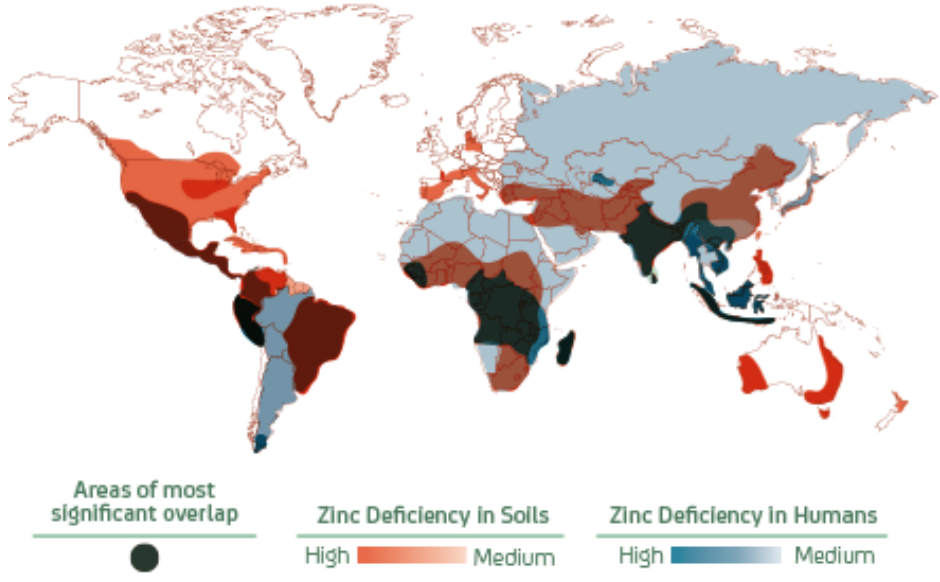
Zinc

- Found in every tissue in the animal body
- Accumulate in the bones
- High concentrations have been found in the skin, hair and wool
- Involved in cell replication and differentiation
- Production, storage and secretion of hormones
- Immune system
- Electrolyte balance

- **Sources**:
  - Widely distributed in foods
  - Yeast is a rich source
  - Bran and germ of cereal grains
  - Animal protein by-products → Fishmeal

Mineral deficiencies - Zinc

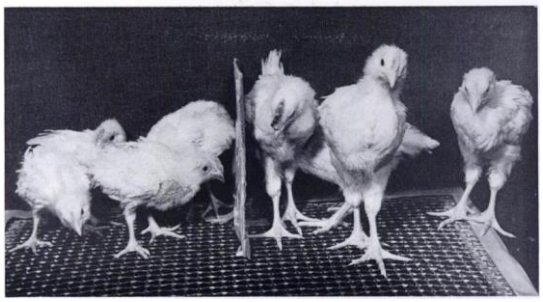
- Needed for protein synthesis and cell division
- Lack of Zinc leads to:
  - Excessive salivation
  - Deformed hooves
  - Stiff joints
  - Skin problems
  - Small testicles and libido
- Mineral blocks in places where problem is endemic



http://rootsforgrowth.com/soilhealth/

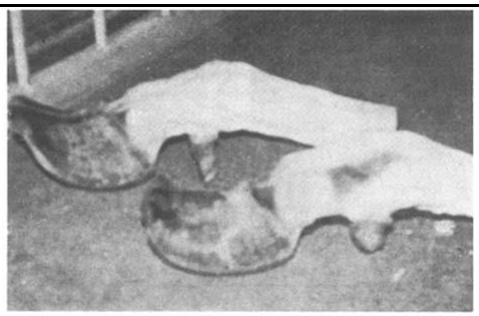
Frizzled feathers of a zinc-deficient chick.

https://www.semanticscholar.org/paper/History-of-Zinc-in-Agriculture-1-%2C-2-Nielsen/5363e355cfa1431a91301f25395c8ecd88cbc8d6/figure/3

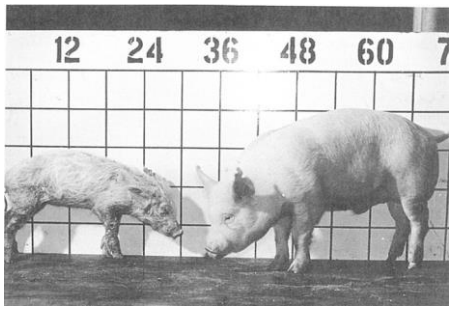


Effect of zinc on zinc-deficient chicks fed a soy protein diet with supplemental histidine. The chicks on the left were fed 0.5% histidine with 5 ppm supplemental zinc in a soy protein diet. The chicks on the right were fed 0.5% histidine with 80 ppm supplemental zinc in a soy protein diet. Note the growth stimulation from zinc, and that neither group shows abnormal legs. The chicks are representative of larger groups of 10 chicks each.

https://www.researchgate.net/figure/Effect-of-zinc-on-zinc-deficient-chicks-fed-a-soy-protein-diet-with-supplemental_fig3_17246647

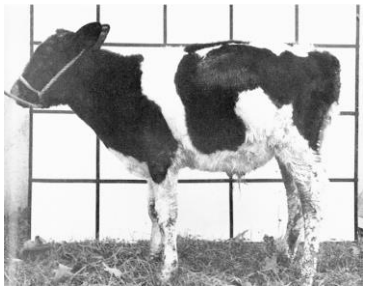


http://www.fao.org/docrep/004/X6512E/X6512E18.htm



Pig showing zinc deficiency signs of parakeratosis and decreased growth. Courtesy of J. H. Conrad and W. M. Beeson, Purdue University.

http://petcare-vetonline.blogspot.com/2009/12/zinc-defeciency-in-domestic-animals.html



Calf showing zinc deficiency signs of parakeratosis.

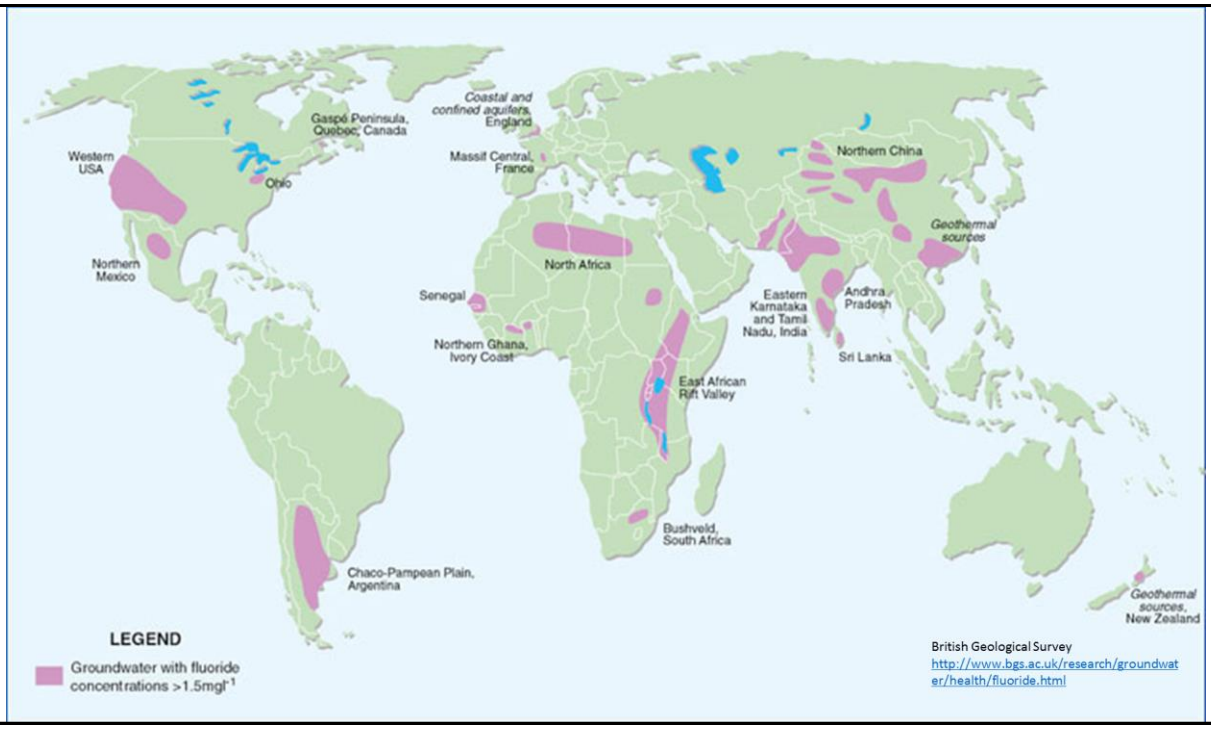
https://www.semanticscholar.org/paper/History-of-Zinc-in-Agriculture-1-%2C-2-Nielsen/5363e355cfa1431a91301f25395c8ecd88cbc8d6

Fluorine/Fluoride

- Prevention of dental caries in humans
- 1972 → growth rate of rats was improved after small amounts were added to a low-fluorine diet → **Fluoride classified as essential**
- Fluorine is a very toxic element
- Ruminants more susceptible

Fluoride toxic effects: Fluorosis

- Occurs where Fluorine/Fluorides contents of water (and feed) are too high
- Poisoning effect → Builds up with time
- Symptoms:
  - Abnormal teeth/dental pitting
  - Abnormal bones
  - Stiff joints
  - Diarrheal
  - Organ damage
  - Appetite loss and emaciation
- Prevention → Not use feeds with high fluorine content



Selenium

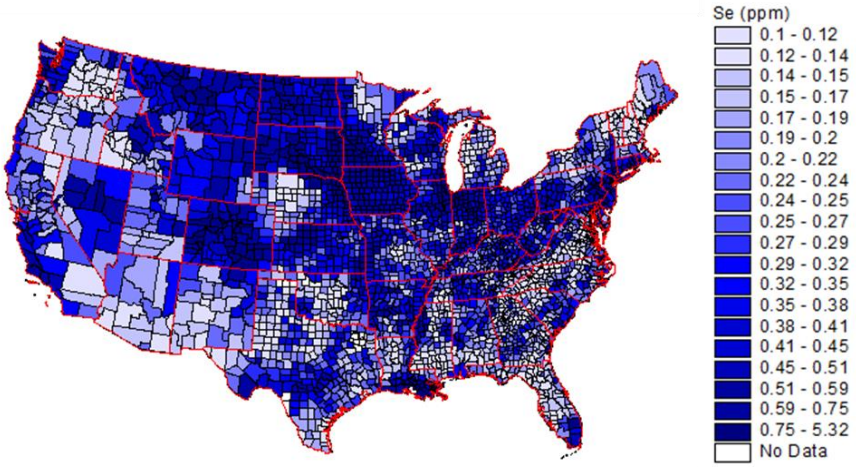
- Importance known since the 1950s
- Component of glutathione peroxidase → removal of hydrogen peroxide → ROS
- Protection of cell membranes from oxidative damage
- Associated to Vitamin E → Protection from oxidative damage

Selenium Deficiency: White Muscle

- Occurs in cattle in areas where there is a deficiency in Selenium in the soil
- Selenium and Vitamin E are antioxidants
- Shortage Selenium → accumulation Free Radicals/ROS
- Results in White Muscle Disease
  - Trouble Walking
  - Trouble Breathing
  - Heart failure

http://www.nadis.org.uk/bulletins/trace-element-deficiency-in-cattle.aspx

Se Deficiency: Provide in diet if a problem in a specific area



Case Study: Vitamin E and Selenium deficiency in Pigs

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Lisbon
(2018)

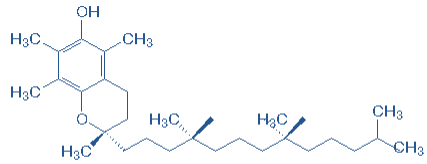
Introduction

- The mammalian body is in a constant state of turnover
- Cell replacement is as a natural renewal mechanism
- Old cells → Oxidation
- Accumulation of Peroxide/Free Radicals

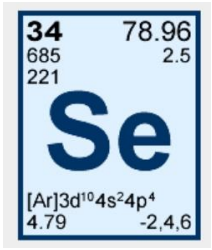
Regular Turnover → Dead Cells → **Accumulation of Peroxide and Free Radicals**

Introduction

- Free Radicals damage tissues
- In healthy bodies are avoided by the presence of anti-oxidants in the diet
- In the pig, the 3 main groups providing anti-oxidant protection are:
  - Bio-flavonoids
  - Vitamin C
  - **Vitamin E and selenium**



Vitamin E （α-tocopherol）



Introduction

Deficiency of anti-oxidants occur → metabolic pathways are disturbed

DAMAGE

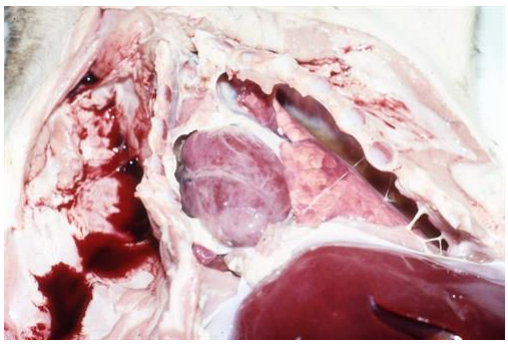
- In the Pig, Selenium and Vitamin E, working in conjunction, are the primary limiting anti-oxidant
- Selenium is key component of glutathione peroxidase →H peroxide removal
- Selenium and Vitamin E deficiency is a major cause for disease

Se & Vitamin E deficiency: Symptoms

- Sudden death
- Particularly in young and fast growing weaners
- Can also be seen in piglets at around 3rd week of life
- Originates 2 different diseases:
  - *Mulberry Heart Disease (MHD) - Miopatia*
  - *Hepatosis dietetia*

Mulberry Heart Disease

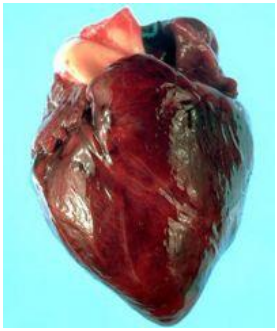
- *Miopatia*
- Toxic peroxides target heart muscle
- Leads to myocardial failure
- heart will generally be enlarged with white streaks throughout the muscle
- Accumulation of 'jelly-like' around the outside of the heart within the pericardium
- Fluid accumulation in the lungs



http://www.nadis.org.uk/bulletins/vitamin-e-selenium-deficiency.aspx

Mulberry Heart Disease

- Affected pigs will often be the best pigs in the group
- Fastest growing pigs have high requirement for Vitamin E/selenium
- Better Performance → Higher susceptibility to MHD
- MHD is more a manifestation of Vitamin E deficiency than selenium shortage.



Hepatosis dietetia

- Damage is done to the liver
- Enlarged liver
- Liver is enlarged and engorged with blood
- Liver has split → resulting in haemorrhage into the abdomen

Both diseases surge as a consequence of Vitamin E/Selenium deficiency

Additional role for Vitamin E

- **Essential for the immune system**
- Challenges will trigger an immune reaction → Use of Se/Vit E

- **Vaccination**
  - Vaccination challenges the immune system
  - Vaccination is only effective if Vitamin E/Se levels are adequate

Sources of Vitamin E and Se

- Sow colostrum → highest possible levels of Vitamin E
- High levels in sow diet in the month prior to farrowing are important
- Weaning → diets must be adequately supplemented with Vitamin E/Selenium and feed intake must increase rapidly to fulfil requirement

Sources of vitamin E

- Widespread in several feedstuffs
- Green fodders
  - Changes with the maturity state of the grass
  - Losses in hay making
- Cereals
- Animal products not a very good source

Not relevant to pigs, except on pasture

Susceptibility

- Fast growing pigs are most susceptible to MHD/Hepatosis dietetia
- Excessive disease challenge post weaning
- Excessive vaccine challenge post weaning
- Highly susceptible breed types

Weaning related stress

Levels of Vitamin E in the Diet

Typical compound diets may have the following levels of Vitamin E:

Sow diets (lactating and dry sow) 100 iu/kg

Creep diets 250 iu/kg
Weaner diets 100-150 iu/kg
Grower and finisher diets 40-100 iu/kg

Product # **8110**

COLORADO SOY COMMERCIAL SWINE FINISHER

For Finishing Swine

GUARANTEED ANALYSIS

Crude Protein, minimum	13.50%
Lysine, minimum	0.80%
Crude Fat, minimum	4.00%
Crude Fiber, maximum	4.50%
Calcium (Ca), minimum	0.40%
Calcium (Ca), maximum	0.90%
Phosphorus (P), minimum	0.50%
Salt (NaCl), minimum	0.20%
Salt (NaCl), maximum	0.70%
Selenium (Se), minimum ppm	0.27
Zinc (Zn), minimum ppm	80
Vitamin A, minimum IU per lb	2,270
Vitamin D_3, minimum IU per lb	460
Vitamin E, minimum IU per lb	10

FEEDING DIRECTIONS

Feed Colorado Soy Commercial Swine Finisher as the sole ration to swine weighing 150 pounds to finish weight.

Rev. 04-28-11

Net Weight 50 lb (22.68 kg) or Bulk

ASE Show Pig with Wormer

18% Medicated Swine Feed

A complete swine starter feed formulated to be fed to show pigs from 0-7 days and 22-28 days. Contains Safeguard Dewormer for removal of lungworms, gastrointestinal worms and kidneyworms.

Active Drug Ingredients

Fenbendazole.....76 g/ton

GUARANTEED ANALYSIS

Crude protein, minimum	18.0%
Lysine, minimum	1.2%
Crude fat, minimum	6.0%
Crude fiber, maximum	6.0%
Calcium , minimum	0.6%
Calcium, maximum	1.1%
Phosphorus, minimum	0.8%
Salt, maximum	0.75%
Salt, minimum	0.25%
Selenium, minimum	0.3 ppm
Zinc, minimum	125 ppm

INGREDIENTS: Grain Products, Plant Protein Products, Animal Protein Products, Dicalcium and Monocalcium Phosphate, Processed Grain By-Products, Grain Products, Flax Seed Meal, Dried Whey, Calcium Carbonate, Salt, Magnesium Oxide, Animal and Vegetable Fat, L-Lysine, dl-Methionine, Choline Chloride, l-Carnitine, L-Threonine, Cane Molasses, Anise Oil, Lactose, Spray Dried Blood Cells, Spray Dried Egg White, Spray Dried Whole Egg, Chromium-Methionine, Vitamin A Supplement, Vitamin E Supplement, Vitamin D-3 Supplement, Niacin, Vitamin B-12 Supplement, Riboflavin, d-Calcium Pantothenate, Ethoxyquin (a preservative), Menadione Dimethylpyrimidinol Bisulfite (Source of Vitamin K Activity), d-Biotin, Folic Acid, Thiamine Mononitrate, Pyridoxine Hydrochloride, Zinc Sulfate, Ferrous Sulfate, Ferrous Oxide, Manganese Sulfate, Copper Sulfate, Ethylene Diamine Dihydriodide, Cobalt Sulfate, Zinc Methionine, Copper Amino Acid Complex, Copper Lysine, Manganese Methionine, Cobalt Glucoheptonate, Ascorbic Acid, Extracted Streptomyces Fermentation Solubes, Lecithin, Potassium Sulfate, Heat Stabilized Saccharomyces Cervisiae, Yeast Culture, Dried Molasses, Dried Aspergillus Oryzae Fermentation Extract, Yucca Schidigera Extract, Dried Aspergillus Niger Fermentation Extract, Kelp Meal, Dried Bacillus Subtilis Fermentation Product, Dried Lactobacillus Bifidobacterium Thermphilum Fermentation Product, Dried Bifidobacterium Longum Fermentation Product, Natural and Artificial Flavors, Selenium Yeast, and Sodium Selenite.

FEEDING DIRECTIONS: Feed continuously for 3-12 days to growing pigs to provide a total intake of 9 mg Fenbendazole per kg of bodyweight (1 lb. of feed contains 38 mg Fenbendazole)

CAUTION: Occasionally, swine fed Lincomycin may, within the first 2 days after the onset of treatment develop diarrhea/swelling of the anus. On rare occasions, some pigs may show reddening of the skin and irritable behavior. These conditions have been self-correcting with 5-8 days without discontinuing the Lincomycin treatment. Do not allow rabbits, hamsters, guinea pigs, horses or ruminants access to feeds containing Lincomycin. Ingestion by these species may cause severe gastrointestinal effects.

WARNING: DO NOT SLAUGHTER SWINE FOR HUMAN CONSUMPTION FOR 6 DAYS FOLLOWING LAST TREATMENT

Manufactured By **ASE Feed & Supply**
211 S. Jefferson Ave., Plain City, OH 43064

NET WT 50 LB (22.67 kg)

Treatment and Prevention

- Additional antioxidants must be provided
- Additional Vitamin E in the diet

Not immediate solutions

- Injectable Vitamin E can be given around weaning
- Vitamin C can be included in creep diets in addition to Vitamin E (only in pelleted diet – not for hot pelleting)

- Avoiding vaccination stress and multiple vaccination challenge

Molybdenum

- 1953 → xanthine oxidase, important in purine metabolism → metalloenzyme containing molybdenum
  - Other enzymes: aldehyde oxidase and sulfite oxidase
- Copper metabolism
- **Deficiency symptoms**: growth problems but Molybdenum deficiency has not been observed under natural conditions in any species
- **Toxicity**:
  - cattle susceptible to molybdenosis
  - scouring and weight loss

Other minerals…

- Silicon
- Chromium
- Vanadium
- Nickel
- Tin
- Arsenic

Silicon

- *Silício* (*Si*); Not to be confused with the silicon-containing synthetic polymer silicone
- Si is essential for growth and skeletal development in chicks: strength, structure and resilience of connective tissue → collagen synthesis
- Silicon-deficient rats and chicks → bone abnormalities
- Widely distributed in the environment and in foods → no deficiency described
- *Silicon toxicity (silicosis) → inhalation (illness of miners)*
- **Excessive Si in feeds → depress organic matter digestibility**

Rice Straw! Do not use in Animal Feeding due to high Si content

1. Depress organic matter digestibility
2. Teeth wear in sheep

https://www.feedipedia.org/node/557

Chromium

- Essential for normal glucose utilisation
- Lipid synthesis? Protein and nucleic acid metabolism?
- Pig → increased lean and decreased fat deposition
- Still being investigated → no recommendations for dietary levels have been made
- Not a particularly toxic element (yet?)

Vanadium

- No specific biochemical function has been identified
- Vanadium deficiency has been demonstrated in rats, goats and chicks
- Deficiency symptoms → impaired growth and reproduction, and disturbed lipid metabolism
- Chickens: reduced growth of wing and tail feathers
- Goats: increased incidence of abortion, reduced milk fat production and a high death rate in the kids

Nickel

- Biochemical function → Not established
- Metalloenzymes? nucleic acid metabolism
- Def.:
  - Chicks → skin pigmentation changes, dermatitis
  - Pigs → scaly and crusty skin

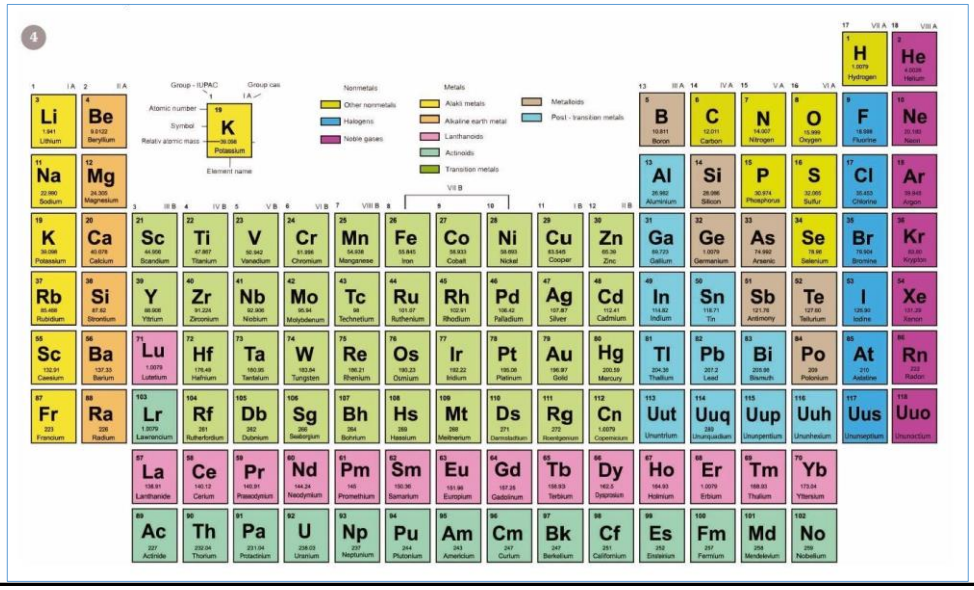
Tin (Estanho)

- Nutritional importance of this element has yet to be determined
- contributes to the tertiary structure of protein

Arsenic (Arsénio)

- Concentrated particularly in the skin, nails and hair
- arsenic-deficient diet had rough coats and slower growth rates
- The toxicity is well known; symptoms include nausea, vomiting, diarrhoea and severe abdominal pain.

What else??????????????



Mineral element	Role	Effects of deficiency
Calcium	Bone and teeth, transmission of nerve impulses	Rickets, osteomalacia, thin eggshells, milk fever
Phosphorus	Bone and teeth, energy metabolism	Rickets, osteomalacia, depraved appetite, poor fertility
Potassium	Osmoregulation, acid–base balance, nerve and muscle excitation	Retarded growth, weakness
Sodium	Acid–base balance, osmoregulation	Dehydration, poor growth, poor egg production
Chlorine	Acid–base balance, osmoregulation, gastric secretion	Alkalosis
Sulphur	Structure of amino acids, vitamins and hormones, chondroitin	Equivalent to protein deficiency (urea-supplemented diets)
Magnesium	Bone, activator of enzymes for carbohydrate and lipid metabolism	Nervous irritability and convulsions, hypomagnesaemia
Iron	Haemoglobin, enzymes of electron transport chain	Anaemia
Copper	Haemoglobin synthesis, enzyme systems, pigments	Anaemia, poor growth, depigmentation of hair and wool, swayback
Cobalt	Component of vitamin B_{12}	Pining (emaciation, anaemia, listlessness)
Iodine	Thyroid hormones	Goitre; hairless, weak or dead young
Manganese	Enzyme activation	Retarded growth, skeletal abnormality, ataxia
Zinc	Enzyme component and activator	Parakeratosis, poor growth, depressed appetite
Selenium	Component of glutathione peroxidase, iodine metabolism, immune function	Myopathy, exudative diathesis

Tropical Animal Health and Production
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REVIEWS

Assessing mineral status in edible tissues of domestic and game animals: a review with a special emphasis in tropical regions

D. M. Ribeiro [1] · M. P. Mourato [1] · A. M. Almeida [1]

Received: 11 January 2019 / Accepted: 20 February 2019

Abstract
Mineral status in edible tissues has been extensively studied since the beginning of the twentieth century. Most research focus on nutrition, as the earliest reports were essentially related to nutrition, animal health and mineral deficiencies. Nutrition wise, minerals are of great importance for consumers worldwide, as meat (i.e. beef, pork, chicken) and fish are major sources of protein in human diets. Nutrition gains renewed importance in the tropical context, since tropical forages are poor in minerals. This fact contributes to mineral deficiencies and impaired production performance in extensive production systems, with greater emphasis in ruminant species. In addition to nutrition, several other factors have an important impact in mineral metabolism such as geographic location, gender and species. In this article, we aim to infer on both the role in the organism and the amount present in various edible tissues of different species, either game or production animals, presenting an overall perspective in the context of tropical animal production.

Keywords Edible tissue · Mineral · Nutrition · Metabolism

Questions?