
Minerals

Preliminary Concepts

- Minerals are inorganic elements found in the body
- not all of them are essential and probably are there simply because of ingestion of feed
- dietary requirement has been demonstrated for at least 22 in one or more species
- those required in large quantities are known as **macro or major minerals**
- those required in trace quantities are known as **trace minerals or elements**

Preliminary Concepts

- Major: calcium, phosphorus, magnesium, sodium, potassium, chlorine and sulfur

- Trace: iron, iodine, manganese, copper, cobalt, zinc, selenium, molybdenum, fluorine, aluminum, nickel, vanadium, silicon, tin and chromium

- determination of dietary or tissue mineral levels is via combustion and collection of residual ash

Principle Mineral Constituents

Element	Percent
calcium	1.33
phosphorus	0.74
sodium	0.16
potassium	0.19
chlorine	0.11
magnesium	0.04
sulfur	0.15

General Functions of Minerals

- Provide rigidity and strength to skeletal structures, exoskeletons
- primary components of bones and teeth
- constituents of organic compounds such as proteins and lipids
- enzyme activators (**coenzymes**)
- osmoregulation, acid/base equillibria
- effect irritability of muscles and nerves

Minerals

- These minerals regulate osmotic balance and aid in bone formation and integrity
- Micro-minerals (trace minerals) are required in small amounts as components in enzyme and hormone systems
- Common trace minerals are copper, chromium, iodine, zinc and selenium.
- Fish can absorb many minerals directly from the water through their gills and skin

MINERALS

- **Required by all animals – fish can uptake some from water**
  - **Formation of skeletal tissue**
  - **Respiration**
  - **Digestion**
  - **Osmoregulation (SW = high minerals/salts, FW = low**
- **Major minerals**
  - **Ca, Phos, Sulphur, sodium, chloride ion, K+, Magnesium**
- **Trace minerals**
  - **Cobalt, Copper, Fluorine, Iodine, Iron, Manganese, etc.**

MINERALS

- **Dietary Phosphorus**
  -
  -
- **Phosphorus reduction**
  -
  - **Increase plant protein**
    - **High in phytate phosphorus**
  -

Requirements by Fish/Shrimp

- Similar to warm blooded animals for tissue formation and various metabolic functions
- can absorb dissolved minerals from the water across gill membrane/exoskeleton
- also via drinking (for drinking species)
- most Ca required comes from water
- for marine species, seawater provides most iron, magnesium, cobalt, potassium, sodium and zinc
- phosphorus not typically available in water

Calcium and Phosphorus

- Ca and P are two of the major inorganic constituents of feeds
- Ca: essential for blood clotting, muscle function, proper nerve pulse transmission, osmoregulation
- P: component of ADP, ATP, P-lipids, DNA, RNA
- Phosphates serve as pH buffer systems

Calcium and Phosphorus

- Dietary Ca is primarily absorbed from the inestine by active transport
- in vertebrates, blood levels of Ca and P are regulated by the vitamin/hormone **cholecalciferol**
- absorption depends upon whether the mineral is soluble at the pH of the gut
- Ca, for example, can be put in the diet as Ca-lactate, Ca-PO_4 tribasic, or $CaCO_3$
- digestibility of above: 58%, 37%, 27%, respectively

Phosphorus Availability

- The main question regards whether the mineral is soluble in water
- monobasic sources (sodium phosphate) are highly digestible (90-95%)
- availability of di- and tri-basic phosphorus sources varies with species, but is generally around 45-65%
- monobasic sources are more expensive

Calcium and Phosphorus

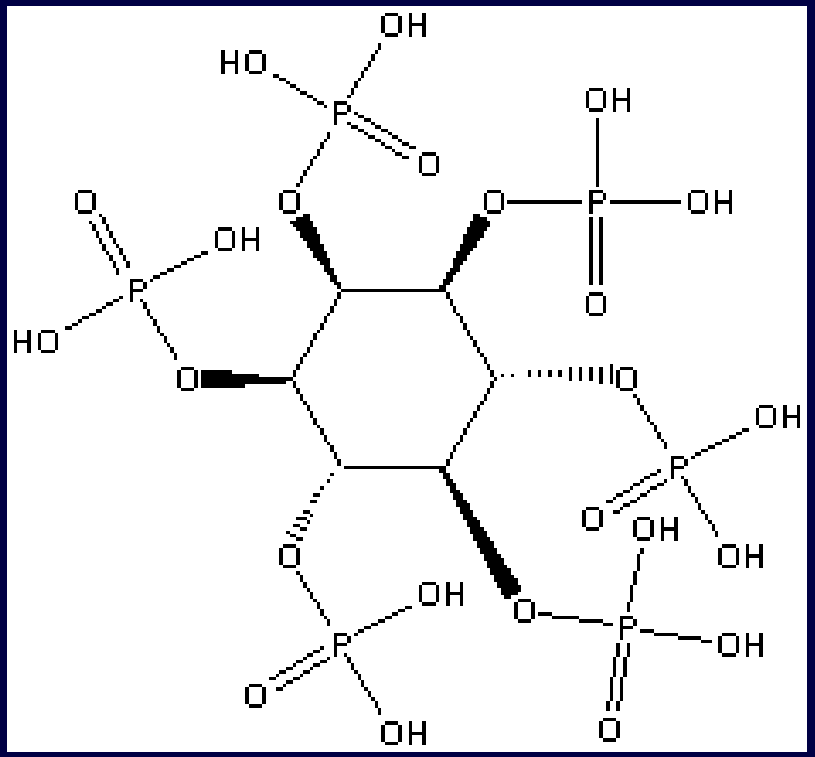
- Besides the form in which it is included in the diet, availability of Ca and P can depend upon:
- 1) level of lactose intake
- 2) dietary form of Vitamin D
- 3) iron, aluminum, manganese, potassium and magnesium intake
- 4) level of fat intake
- 5) level of dietary phytate (phytic acid)
- obviously, many interactions

Calcium and Phosphorus

- No dietary Ca for shrimp grown in seawater (why?)
- Since levels of P are low in most natural waters, there is a dietary requirement
- Supplementation of dietary Ca inhibits P availability
- Thus, dietary ratios of less than 2:1 Ca:P are recommended

Phosphorus Availability

- The major source of P in natural grains (67%) is a compound known as **phytate phosphorus**
- this form of P is poorly available
- the presence of phytate inhibits the availability of dietary Ca and other sources of P
- forms insoluble complexes in the digestive system



phytic acid