Fish_Vitamins and Minerals Requirements

General Concepts

- Divided into two major groups: **fat soluble** and **water soluble**
- fat soluble: A, D, E, K
- most of the 15 shown as essential for fish, but not for all species
- requirements vary with species, size, growth rate, environment (temperature, presence of toxins, etc.) and metabolic function (growth, stress response, disease resistance)
- many species can utilize intestinal bacteria synthesis for meeting vitamin requirements

VITAMINS

- COMPLEX SUBSTANCES
- FAT SOLUBLE VITAMINS
  - A- Retinol - carotenoids converted in intestinal mucosa
  - E - Tocopherol - antioxidants in fish diets*
  - K - Two forms in green plants - blood clotting and bacteriostatic
  - D - calciferols not well understood

WATER SOLUBLE VITAMINS PATHOLOGY IN FISHES

- B_1 - coenzyme of carbohydrate metabolism
  - digestion, reproduction, nervous system
- B_2 - Riboflavin- eyes function, cataracts
- B_6 - Pyridoxin
- Pantothenic acid
  - Lamellar hyperplasia
- Inositol - reduced growth rates

WATER SOLUBLE VITAMINS

- **Niacin - haemorrhage erosion epidermis**
- **Biotin - can cause darkening anorexia**
- **Choline -poor growth and conversion**
- **Cyanocobalamic (B_{12})- anemia**
- **Folic acid - haemopoiesis - erythrocytic anemia**

WATER SOLUBLE VITAMINS

- **Ascorbic Acid (C) ***
  - **Important - Collagen skeletal systems**
  - **Wound healing, disease resistance**
  - **Fish and primates can not synthesize**

Vitamin A: retinol

- Can only be found intact in animal sources in its natural form, it is alcohol known as retinol also isolated from various lipids and beta carotene 1 beta carotene (plants) ~ 2 retinols (body) stored in the liver
- retinol + opsin (protein) = rhodopsin (vision)
- deficiency = improper growth, exophthalmia
- feeds contain non-oxidizable form, proper storage
- requirement level = 1,000 I.U. (international units)
- sources: fish oils

Vitamin D_3: cholecalciferol

- Vitamin D found as ergocalciferol (D_2) and cholecalciferol (D_3)
- most land animals can use both, except chickens (only D_3)
- fish appear to use only D_3
- both activated in plants/animal skin by UV radiation
- D_3 primarily used as precursor for calcium regulation

Vitamin E: tocopherol

- Active form is alpha tocopherol
- good antioxidant: most feed antioxidants have vit E activity, but only 1/6 that of α-tocopherol
- antioxidants used to prevent oxidation (spoilage) of lipids (HUFAs & PUFAs)
- requirement is tied to selenium deficiency (Se is cofactor in glutathione peroxidase)
- deficiency in fish = muscular dystrophy, reduced fertility
- increased dietary requirement in absence of PUFA's
- requirement: 50-100 mg/kg for fish/shrimp
- sources: alfalfa meal, fish meal, rice bran, wheat middlings, barley grains

Vitamin K

- Originally identified as a “fat-soluble factor” required for normal blood clotting
- actually works by activating blood-clotting proteins
- requirement: shrimp (none), fish (unknown)
- dietary sources: alfalfa meal, liver meal

Water Solubles: thiamine (B_1)

- Function: metabolism of COH
- sources: brewers yeast, wheat middlings, rice bran, rice polishings, wheat bran, soybean meal
- deficiency: central nervous system failure
- requirement: 2.5 mg/kg (tilapia), 10-15 mg/kg (salmon)
- requirement: 40-50 mg/kg (shrimp)

Riboflavin: B_2

- Function: metabolic degradation of proteins, COH, lipids
- sources: plants, bacteria, yeast, fish solubles
- deficiency: cataracts (fish), vision, crooked limbs
- requirements: 9 mg/kg (channel catfish), 5 mg/kg (tilapia)
- requirements: 50 mg/kg (shrimp)

Niacin

- Function: transport of hydrogen ions as NADP, NADPH; electron transport, fatty acid, cholestrol synthesis
- forms: niacin, nicotinic acid, nicotinamide
- sources: rice polishings, yeast, rice bran
- deficiencies: pellagra (dermatitis), anemia (fish), skin lesions (fish), sunburning (fish)

- Can fish convert tryptophan to niacin? (Data inconsistent.)

- requirements: 14-28 mg/kg (carp, catfish)
- requirements: 400 mg/kg (shrimp)

Folic Acid

- Recently shown as very important for pregnant females to avoid birth defects
- function: synthesis of purines, pyrimidines, nucleic acids
- sources: yeast, alfalfa meal, full-fat soybeans
- deficiencies: anemia, large erythrocytes, pale gills (fish)
- requirements: 1-4 mg/kg (fish, shrimp)

Cyanocobalmine

- Last of 15 vitamins to be identified
- chemically complex, cobalt nucleus
- function: coenzyme in metabolic reactions, maturation of erythrocytes, uracil->thymine
- deficiency: pernicious anemia, nerve disorders
- requirement: very low 0.015 mg/kg or not at all

Ascorbic Acid: C

- Both finfish/shellfish very sensitive to this vitamin, especially as juveniles
- function: antioxidant, stress reducer, bone calcification, iron metab, tyrosine metab, blood clotting
- deficiency: scoliosis (lateral), lordosis (vertical), fin erosion, black death (shrimp)
- toxicity: toxic at over 150-200 mg/kg (shrimp)
- sources: synthesized from glucose, usually added as chemical form
- requirement: 100 mg/kg varies w/age, metabolism