Vitamins

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VITAMINS

- Vitamins are organic compounds required in tiny amounts for essential metabolic reactions in a living organism
- Absence or deficiency of vitamins causes deficiency disorders
- Term Vitamin given by Casimir Funk in 1912
- Derived from plants except Vit B12

CLASSIFICATION

- Classified based on their solubility as fat soluble vitamins and water soluble vitamins.

I) **Fat-soluble vitamins** : vitamin A, D, E and K.

II) **Water-soluble vitamins**: vitamin B complex group and vitamin C.

B complex group include:

- Vitamin B1 (thiamin)
- Vitamin B2 (Riboflavin)
- Vitamin B3 (Niacin/Nicotinamide/Nicotinic acid)
- Vitamin B6 (Pyridoxine)
- Panthothenic acid
- Folic acid
- Vitamin B12 (Cyano cobalamine)
- Biotin
- Choline

DIFFERENCES BETWEEN FAT SOLUBLE AND WATER SOLUBLE VITAMINS

Differences	Fat soluble	Water soluble vitamins
Names	**A,D,E,K**	**Vitamin C & B complex**
Solubility	**Soluble in fats and organic solvents**	**Soluble in water**
Digestion and absorption	**Requires fat and bile**	**Easily absorbed in intestine**
Excretion	**Via feces**	**Via Urine**
Storage	**Stored in the body in fat depots and in liver**	**Not stored in body except Vitamin B12 (liver)**
Toxicity	**An overdosage can lead to toxicity**	**Usually not toxic as it is readily excreted when given in excess**

VITAMIN A

- In plant exist in provitamin form i.e. carotenoids
- Vit A exist only in animal origin feeds
- Occurs in three forms: Retinol, Retinal, Retinoic acid
- 1molecule of carotene yields: 2 molecule of Vit A
- β-carotene is most active carotenoids
- β-carotene oxidation $\xrightarrow[\text{Intestinal mucosa \& liver}]{\text{Dioxygenase \& Retinol reductase}}$ Retinol
- Buffalo can convert carotene to Vit A but cow can not hence cow milk is yellow

Vitamin A: Functions

1) **Vision**

- Synthesis of the visual pigment **Rhodopsin**

2) **Bone growth**

- Control **osteoblastic & osteoclastic** activity

3) **To maintain integrity of epithelial cells**

- Required for formation of **mucous secreting epithelium**
- In absence of Vit A, **keratinization** occurs which causes **reduce resistance** for entry of infective organism
- Play imp role in combating infection so called as **Anti-infective vitamin.**

Vitamin A: Deficiency

1) **Night Blindness**

2) **Xeropthalmia**

- **Advance stage** of deficiency
- **Dry cornea & conjunctiva**, cloudiness & **ulceration**, **keratinization** of the cornea, **blindness**
- White patches on white portion eye: **Bitot spot**

3) **Nutritional roup in poultry**

- **Rhinitis**, nasal & ocular discharge, **stuck eyelid** with thick exudate rapid & difficult breathing

4) **Keratinization of epithelium**

5) **Reduced reproductive performance**

Vitamin A: Deficiency

6) **Bone deformities.**

7) **Nervous lesion**

- Skeletal growth retarded but brain grows which create pressure in nervous tissue causes increased CSF pressure

8) **Congenital blindness**

- Optic foramen is not formed properly.
- Small size optic foramen leads to the constriction of optic nerve.
- Permanent damage to the nerve can lead to permanent blindness.

Sources

- Animal source: Fish liver oils, egg yolk, milk fat
- Plant source: All green leaves are rich in provitamin A, beta-carotene.

Vitamin D

- Ergosterol in plant $\xrightarrow{\text{UV light}}$ Ergocalciferol (D2)
- 7-dehydrocholesterol $\xrightarrow{\text{UV light}}$ Cholecalciferol (D3)
- Also called as antirachitic factor
- Resembles to steroid hormone
- Active form D3 stimulate synthesis of CaBP- Ca absorption
- Required for calcium and phosphorus deposition in bones

Vitamin D: Deficiency

- Rickets in young ones
- Osteomalacia in adult
- Retarded growth, decreased feed consumption
- Increased loss of Ca & P in urine
- Poultry: thin shelled eggs, reduced hatchability, enlarged parathyroid gland

Sources

- Cod liver oils (rich source)
- Egg yolk and sun dried roughage's/grains
- Provitamin D: Ergosterol - plant and 7-dehydrocholestrol – skin of animals.

VITAMIN E

- Out of eight natural forms alpha tocopherol is more active
- Natural antioxidant: Firstly, radicals are scavenged by vitamin E secondly, glutathione peroxidase destroys any peroxide formed before they can damage the cell.
- Helps in absorption & utilization of Vit A & extend storage of Vit A in liver by protecting from oxidation
- Also plays an important role in the development and function of the immune system.
- Important for reproduction

Vitamin E: Deficiency

1) **Infertility in female, reduced sperm motility in males**

2) **Nutritional myopathy/white muscle disease**

- **Mulberry heart disease in pigs**

3) **Encephalomalacia/crazy chick disease: chick is unable to walk or stand, and is accompanied by haemorrhages and necrosis of brain cells.**

4) **Exudative diathesis: Oedema of the subcutaneous fatty tissues, associated with an abnormal permeability of the capillary walls**

Sources

- **Green fodders, cereal grains, vegetable oils, fats, and nuts, oil seeds and legumes**

VITAMIN K

- K1: Phylloquinone – Green plants & oil seeds
- K2: Menaquinone – Intestinal bacteria
- K3: Menadione – Synthetic product
- Required for synthesis of prothrombin & other clotting factors
- Vitamin K is also called as anti haemorrhagic vitamin
- Involve in electron transport & oxidative phosphorylation
- Synthesized by GI tract microorganisms

Vitamin K: Deficiency

- Low prothrombin level in blood leads to haemorrhagic conditions
- Sweet Clover disease: Mould infested sweet clover contains a compound dicoumarol, which is potent vit. K antagonist leading to haemorrhagic disease
- Deficiency more common in poultry

Sources

- Green leafy vegetables, egg yolk, liver, fish and synthesised by bacteria in GI tract.

VITAMIN C

- Ascorbic acid
- Synthesized in all animals except human & guinea pigs: they lack L-gluconolactone oxidase required for Vit. C synthesis from 6 carbon sugar
- Plays an important role in the formation of collagen and intercellular cement substance
- Plays an important role in the oxidative reduction reaction of living cells (Antioxidant)
- Also used as preservative in canning & freezing industry

Vitamin C: Deficiency

Scurvy

- Dry, rough skin covered with reddish spots
- Weakness, bleeding, ulcerated gums, loosening of teeth, swollen joints & haemorrhages

Sources

- Citrus fruits, tomatoes, potatoes and green leafy vegetables are rich sources.

Thiamin (B1)

- **Thiamine pyrophosphate** is a coenzyme involved in oxidative decarboxylation of **pyruvate to acetyl COA**. and of **alpha ketoglutarate to succinyl COA** in **TCA cycle**.

Deficiency

- **Beriberi (man)/ polyneuritis (chick):** Accumulation of intermediates of carbohydrate metabolism (lactate, pyruvate & oxaloglutarate) causes **neuritis**
- Chicks sit on flexed legs & draws head backward-**star gazing**
- **Polioencephalomalacia** (ruminants): Thiamin hydrolyzed by **thiaminase** in rumen- Circling movements, opistotonus, convulsion & death

Sources: Yeast, bran, rice polish, egg yolk liver kidney. Pork is rich in thamine.

RIBOFLAVIN (B2)

- It is a constituent of flavin mononucleotide (FMN) and Flavin adenine dinucleotide (FAD)- used by cells to transport hydrogen in metabolic pathway
- Involved in amino acid and carbohydrate metabolism

Deficiency

- Degeneration of myeline sheath
- Lost integrity of epithelium
- Curled toe paralysis (poultry): peripheral nerve degeneration
- Swine: stiff legs, nerve degeneration, corneal opacity, cataract

Sources: Synthesised by yeast, bacteria and fungi. Rich sources are liver, yeast, milk, egg and green leafy vegetables

Niacin/ Nicotinic acid

- Nicotinic acid: Plant; Nicotinamide: Animals
- Component of NAD & NADP: CHO, protein & lipid metabolism
- Tryptophan is precursor of niacin (except cat & mink)

Deficiency

- Black tongue (dogs): inflammation of gums, dark patches on tongue, drooling of bloody saliva
- Pellegra/blue tongue (man & pigs)

Sources: Rich sources of are liver, yeast, groundnuts and sunflower meals. In cereals the vitamin is present in the bound or coenzyme form.

Pyridoxine (B6)

- Component of pyridoxal phosphate (PP) which act as coenzyme for transaminases & decarboxylases
- Required for metabolism of tryptophan

Deficiency

- Pigs: reduced appetite, microcytic hypochromic anemia, convulsion, slow growth
- Poultry: Chicks show jerky movements, in adult birds hatchability & egg production are adversely affected

Sources: Chemically bound to protein in many sources

- Groundnut meal, rice bran, wheat bran, molasses, liver and milk

PANTOTHENIC ACID

- Constituent of coenzyme A, which is the important for acyl transfer.
- It is also a structural component of acyl carrier protein, which is involved, in the cytoplasmic synthesis of fatty acids

Deficiency

- Pigs: Goose-stepping, thin hairs, brownish secretion around eye, slow growth
- Chicks: Retarded growth, poor feather development, granular eyelid, scab around mouth

Sources: Rich sources are liver, egg yolk, groundnuts, peas, yeast and molasses. Cereal grains and potatoes are also good sources of the vitamin

BIOTIN

- Earlier called Vitamin H
- Transfer of carbon dioxide from one substrate to another
- Avidin in egg white protein is antimetabolite to biotin

Deficiency

- Pigs: foot lesions, alopecia (hair loss) and a dry scaly skin.
- Poultry: causes reduced growth, dermatitis, leg bone abnormalities, cracked feet, poor feathering and fatty liver and kidney syndrome (FLKS).

Sources: Biotin is widely distributed in foods; liver, milk, yeast, oilseeds and vegetable are rich sources

Folic Acid

- Coenzyme in the mobilization and utilisation of single-carbon groups (e.g.) formyl, methyl

Deficiency

- Chicks and turkeys: poor growth, anaemia, poor bone development and poor egg hatchability
- Macrocytic, hyperchromic anaemia in humans

Sources: Dark green leafy materials, cereals and extracted oilseed meals are good sources

CHOLINE

- Component of phospholipid lecithin
- Metabolic essential for building & maintaining cell structure
- It also plays an important part in lipid metabolism in the liver
- Component of acetylcholine which is responsible for the transmission of nerve impulses.
- It serves as a donor of methyl groups
- Choline can be synthesized in the liver from methionine.

Deficiency: Perosis, slow growth, fatty liver

Sources: Green leafy materials, yeast, egg yolk and cereals are rich sources of choline

VITAMIN B12

- Cynocobalamin, Stored in liver
- Plant do not synthesize Vit B12
- Synthesized by rumen bacteria when sufficient Co is available
- Synthesize methyl group from one carbon precursor
- Concerned in synthesis of RNA, DNA, essential for cell division
- Control protein synthesis
- Necessary for the conversion of methylmalonyl COA into succinyl COA

Deficiency: Poor growth, Poor feathering, Decreased hatchability, Dermatitis and rough coat.

Sources: Liver kidney excellent sources, meat & fish moderate sources

Thank You