

UNIT 7: VITAMINS

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1.0 Introduction

The previous units treated the Vitamin nutrients in food. These nutrients are carbohydrate, lipids and mineral elements. This unit is treating the last set of nutrients to be discovered. These are vitamins — organic substances needed in small amounts (few micrograms to a maximum of above 30 milligrams) and they perform a specific metabolic function.

They are supplied from the dietary sources.

This unit treats various vitamins, their functions and the problems associated with their deficiency.

2.0 Objectives

At the end of this unit, you should be able to

- List the Classes of Vitamins

- List the Functions of Vitamins
- Discuss the Deficiencies of Vitamins
- Discuss fat soluble vitamins under sources, functions, requirements and deficiencies.
- Discuss some water soluble vitamins under sources, functions requirements and deficiencies.

3.0 Main Content

3.1 Classification of Vitamins

Vitamins are organic substances that are required in small amount — some in few micrograms to a maximum of about 30 milligrams. They perform a specific metabolic function in the body. Some substances that are considered as vitamins for some animals may not be vitamins for some other animals which can synthesize these substances. For instance vitamin C is considered as vitamins for human beings, monkeys and guinea pigs but this vitamin is synthesized by rats, rabbits, dogs and other animals.

The vitamins are manufactured by the plants from the nutrient available to them by the soil. There are eleven water soluble vitamins into vitamin B group and Vitamin C. The Vitamin B group is: Thiamin (B), Riboflavin (B), Pantothenic acid, Biotin, Pyridoxin (B1), Niacin (B3), Folic acid, Cobalamin (B12), Vitamin C or Ascorbic acid is also water soluble.

The fat soluble Vitamins are: Vitamins A, D, E, and K.

There are some compounds that are related to Vitamins, these are precursors (Pro-Vitamins) and Antagonist (Anti-Vitamins). The precursors of vitamins are converted in the body to the active forms of the vitamins. Carotene, the precursor of vitamin A is converted to vitamin A in the intestinal wall. 7-dehydrocholesterol is converted to Vitamin D in the skin and to the active form in the liver and kidney when the body is exposed to the sunlight energy especially early in the morning. Tryptophan is converted to Niacin in the liver.

The anti-vitamins prevent the functioning of the vitamins by refusing to be replaced by the active vitamin in those compounds that will allow the vitamins to perform their roles.

3.2 Functions of Vitamins

The vitamin functions as part of the body. So the vitamins exist as part of enzymes in the metabolic functions of the body. So the vitamins exist as Co-enzymes in the body. Some enzymes cannot perform their roles in the body except these co-enzymes exist and combine with the vitamins.

3.3 Deficiencies of Vitamins

The deficiencies in vitamins can arise from the following reasons:

- a. Inadequate supply of the vitamins from the diet. The vitamin requirements of people vary. The amount of a vitamin that is sufficient for a person may be insufficient for another person.
- b. The failure of the body to absorb vitamins required by the body may cause the deficiency of the vitamins in cells. If a person cannot secrete enough bile, the absorption of fat soluble vitamins will be lower than required. Very rapid passage of food through the intestinal tract may also reduce the absorption of nutrients.
- c. Increased need for a vitamin may also precipitate the deficiency of that vitamin if additional intake over and above the original intake is not made.
- d. Losses of vitamin through processing of the food may also cause deficiency of the vitamins in the diet consisting the foods.

3.4 Fat Soluble Vitamins

3.4.1 Vitamin A

Vitamin A occurs in several forms in nature. It occurs as retinol in mammals and saltwater fish; as dehydroretinol in fresh water fish, as pro-vitamins (Precursor) known as Carotenes. Vitamin A is supplied to the body through dietary intake or supplements. Excess amount of vitamin A consumed over the required amount in the body is stored in the liver for future use. For maximum utilization of vitamin A in the body, there must be adequacy in the dietary intake of proteins and vitamin E.

Vitamin A is almost colourless, fat soluble and relative to heat. Exposure to light may destroy vitamin A. Storage of vitamin A is associated with fatty acid most especially palmitic acid.

Functions of Vitamin A

Vitamin A is used by complex organisms such as human beings for at least three physiological functions namely:

- Vision
- Growth
- Reproduction

For vision, vitamin A is used for the maintenance of the visual pupil for vision in dim light. In other words it prevents night blindness.

For growth, vitamin A plays an important role in the development and maintenance of epithelial tissue and the development of bones.

For reproduction, retinol or its aldehyde derivative (retinaldehyde) is necessary for normal reproduction in rat. Absence of vitamin A causes failure in spermatogenesis in male i.e. manufacturing of sperm and foetal resorption in female.

Other functions of vitamin A include

- The role of vitamin A in the release of proteolytic enzymes from particles in the lysosomes.
- Vitamin A is involved in the stability of cell membrane.
- Deficiency of vitamin A has been found to cause changes in which results in loss of appetite.

Food Sources of Vitamin A

Vitamin A is found in fruits and vegetables such as spinach, carrot, asparagus, peas, cabbage, papaya, watermelon, oranges, banana, and pineapple. They are also found in dairy products such as milk, cheese butter and margarine. They are also found in fish, meat, poultry and eggs such as liver, beef, lamb, chicken, calf, pork, egg yolk and whole egg. In milk vitamin A is present in the fat position. In fruits and vegetables, vitamin A is present in form of precursor. Vitamin A is also available in only animal product which the carotene in their foods has been metabolized into vitamin A. the liver of such animal is the storage site of Vitamin A.

Deficiency of Vitamin A

Deficiency of vitamin A only occurs after the reserve *in* the liver has been completely depleted when there is very low dietary intake of the vitamin. Vitamin A deficiency results into

- a. Night blindness
- b. Changes in the *eye* with the cornea first affected
- c. Respiratory infections
- d. Changes in skin with the development of folliculosis, that is development of small bumps near the base of hair follicle that subsequently becomes keratinized
- e. Changes in gastro-intestinal tract resulting into disturbances such as diarrhoea.
- f. Failure of teeth enamel in which the enamel in the teeth disappears as a result of deprivation in vitamin A.
- g. There could be loss of sense of smell and taste.

Toxicity in Vitamin A

This is also known as hypervitaminosis of vitamin A. This results in the decreased stability of the membrane structure. It can cause the fragility of bones and also result in increase of calcium in both urine and blood therefore, resulting in low amount of calcium laid down in the bones.

Recommended Allowances for Vitamin A

The recommended allowances for vitamin A have been given as 5000 IU for an adult male per day, 4000 IU for women per day, 5000 IU for pregnant women per day and 6000 IU for a lactating mother per day. There are recommended amounts for people of other age groups in many books on nutrition. The need of vitamin A has been found to vary under different conditions. Performing tiring work in hot weather tends to increase the need for vitamin A.

After removal of the gall bladder in hypothyroidism and when there is impairment of intestinal absorption of vitamin A, there is a need of increase in dietary intake of vitamin A.

3.4.2 Vitamin D

This is also a fat soluble vitamin that exists as a cholecalciferol, vitamin D₃, in animal sources and ergosterol, vitamin D₂, from vegetable sources. Previously it is known as sunshine vitamin and rickets preventive factor since it could be used to prevent or cure infants of rickets; if the infants are exposed to sunlight or if they receive their vitamin D from cod-liver oil.

We should know that rickets is the condition that is characterized by defective bone formation in which there is inadequate deposition of calcium and phosphorous in the bone.

This results into deformity in the bones of the leg leading to bowing of legs and knock-knees. Rickets is primarily associated with children. The term "adult rickets" that is Osteomalacia results in the defect in the bone formation but not necessarily as a result of vitamin D deficiency.

Functions of Vitamin D

It is very useful in the metabolism of calcium as it is associated with the calcification of bones. It also acts to raise the blood calcium levels by facilitating the resorption of bones (Guthrie, 1979).

It is also involved in the metabolism of phosphorous as failure in calcification of bone is often caused by insufficient supply of phosphates. It has been found that the addition of vitamin D to the diet causes an increase in the rate of absorption of phosphates.

Vitamin D, has been found to influence the rate of resorption of amino acid in the kidney tubules.

There is also an antagonistic relationship between vitamin D and hydrocortisone, an hormone of the adrenal gland. It should be noted that the hydrocortisone can suppress the high blood level of calcium that is associated with the excessive intake of vitamin D.

Sources of Vitamin D

Vitamin D is produced majorly by the exposure of the adipose tissue to ultraviolet rays in sunlight. Food sources also provide some relatively small amount of vitamin D. Margarine enriched with vitamin D and egg yolk are important sources of vitamin D. Other sources of vitamin D are fatty fish, butter, dietary supplement in form of fish liver oil fortified in infants and invalids' food.

Requirements of Vitamin E

For pregnant and lactating mothers the requirements has been set as 15 Iii. The recommended intake of vitamin E for adult male has been put at 15 IU per day and for adult female it has been put at 12 IU per day.

Source of Vitamin E

Vitamin E is found mostly in vegetable oils. It is also found in wheat and oil. Normal cooking causes little destruction of vitamin E. Fruits and vegetables are relatively poor sources of vitamin E

3.4.4 Vitamin K

Vitamin K is also a fat soluble vitamin called Anti-hemorrhagic factor. It belongs to the substance known as Quinones. Vitamin K is involved in the synthesis of blood clotting factor.

Vitamin K is derived from green and yellow vegetables and from its synthesis in the body by intestinal vertebra. Prolonged coagulation time and frequent incidence of hemorrhage are the few symptoms of vitamin K deficiency.

Student Assessment Exercise 7.1

Discuss the classification and functions of Vitamins.

3.5 Water Soluble Vitamins

3.5.1 Thiamin (BO

Thiamin occurs in the body mostly as thiamin hydrochloride, a white crystalline water soluble substance that is easily destroyed by heat or oxidation in the presence of alkaline.

Functions of Thiantin

Thiamin is part of the co-enzyme thiamin-pyrophosphate or thiamin diphosphate which is required for the metabolism of carbohydrate.

Rice. enriched with thiamin has been found to eliminate the incidence of beriberi.

Food Sources of Thiamin

Thiamin is found in cereal product providing about one-third of dietary thiamin. Meat, fish and poultry provide a fourth and dairy products a tenth of the available dietary' thiamin. Food sources of thiamin are yeast, pears, pork, - orange drink, whole wheat bread, macaroni and wheat bread.

Deficiency of Thiamin

The deficiency is caused by low dietary intake of thiamin and caloric intake in the diet.

Deficiency of thiamin results into loss of appetite or anorexia, decrease muscle tonus, mental depression and confusion, nystagnus caused by weakness of the cranial nerve and beriberi. There could even be growth retardation in animal if there is deficiency of thiamin.

Requirements of Thiamin

There is always a relationship between the caloric intakes for the thiamin need for all ages. The need for thiamin per day varies from 0.5 to 0.9mg in children. For boys, girls, men and women 1.2mg,, 1.0mg, 1.2mg, 0.9mg of thiamin per day respectively are recommended.

3.5.3 Riboflavin

This is known as vitamin B₂ and it is known as essential for growth and tissue repair in all animals it is relatively resistant to effect of acid, heat and oxidation. Major losses of riboflavin in food can be due to ultra violet or physical rays of sunlight on milk, a major source of riboflavin.

Functions of Riboflavin

Riboflavin has been found to be part of several enzymes and co-enzymes that are involved in a number of metabolisms in the body.

Food Sources of Riboflavin

Milk is the most significant source of riboflavin. Riboflavin is also found in kidney, beef, liver, egg, asparagus and so on. The recommended intake of riboflavin is based on caloric intake as it is set as 0.55mg per 100Kcal during pregnancy additional allowance of 3mg is made during lactation, additional allowance of 5mg is also made per day.

3.5.3 Ascorbic Acid (Vitamin C)

This is a water soluble vitamin that is closely related to monosaccharides. The vitamin is stable to acid but easily destroyed by oxidation, alkali and heat.

It has a molecular formula of $C_6H_8O_6$ which can under go oxidation dehydroascorbic acid ($C_6H_6O_6$)•

Ascorbic acid plays a growth promoting function. Ascorbic acid sulphate also has anti-scorbutic properties of Ascorbic acid. Those animals that have the ability to synthesize vitamin C require no dietary intake of vitamin C. in this process, glucose or galactose is converted to Ascorbic acid. Human beings, guinea pigs and some bats rely on dietary supply of vitamin C for their vitamin C requirement since they lack the enzymes to synthesize vitamin C.

During ripening process in plants, there is the accumulation of vitamin C.

Food Sources of Vitamin C

Vitamin C is found mostly from food from plants. Except liver, no animal source supplies significant amount of vitamin C.

Some of the best sources of vitamin C are citrus fruits and their juices. Tomatoes and cabbage also supply some significant amounts of vitamin C. During processing of foods containing vitamin C care must be taken to prevent loss of vitamin C through leaching and destruction by heat.

Functions of Vitamin C

- a. In vitamin C deficiency, there is the failure of formation of collagen
- b. Ascorbic acid has been implicated in the changes in tooth structure during the critical stage of tooth formation
- c. Vitamin C is necessary for the normal oxidation of large amounts of tyrosine — an amino acid.
- d. The presence of vitamin C in the intestinal tract facilitates the absorption of iron and calcium
- e. The conversion of the inactive form of folic acid (a vitamin B group) to the active form is catalyzed by ascorbic acid.

Deficiency of Vitamin C

Deficiency of vitamin C leads to scurvy in children and young people more than in adults.

Deficiency of vitamin C may also result into weakness, irritability, loss of weight, pains in muscles or joints and gum bleeding.

In deficiency of vitamin C, wounds do not heal easily. There is the reduced ability to resist generalized infection.

Requirements of Vitamin C

There is no hypervitaminosis of vitamin C as we have in vitamins A and D. The requirements of vitamin C vary from 35mg/day in infant to 45mg/day on adults. For pregnant and lactating mothers 60mg and 80mg are the daily dietary allowances recommended.

Student Assessment Exercise 7.2

Discuss vitamin C under chemical properties, food sources, functions, requirements and deficiency.

4.0 Conclusion

This unit treats vitamins and their functions. The unit also shows the classes of vitamins as water soluble and fat soluble vitamins. Some of the vitamins in the groups are treated under chemical nature, food sources, requirements, functions, deficiency and toxicity.

5.0 Summary

The vitamins are classified as fat soluble and water soluble. The fat soluble vitamins are vitamins A, D, E and K. There are eleven water soluble vitamins — the vitamin C and the vitamins B group. The B-group vitamins are given as thiamin (B₁), inositol, choline, Riboflavin (B₂), pantothenic acid, Biotin, Pyridoxine (B₆), Niacin (B₃), Folic acid and cobalamin (B₁₂).

There is no toxic effect of excessive consumption of most vitamins except those of vitamins A and D. These hypervitaminosis A and D vitamins consumed in very minute amounts in the body. Vitamin B₁₂. Thiamin is an anti-beriberi factor, vitamin C, an antisorbic factor, Niacin -- Pellagra

preventive factor, vitamin E — anti-sterility factor and vitamin K an anti-hemorrhagic factor.

Some of the vitamin from the two groups are discussed under chemical nature, requirements, food sources, functions, deficiency and toxicity.

6.0 Tutor Marked Assessment

Discuss the following vitamins under functions and

deficiency a. Vitamin A

b. Vitamin D

c. Vitamin E

Answers to Student Assessment Exercises

7.1 See Section 3.1 and 3.2 of this unit for answers

7.2 See Section 3.5.3 of this unit for the answers

7.0 References and Other Sources

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