VITAMINS

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Summary

Vitamins are complex organic compounds which are required for the normal growth and maintenance of human organism. The human organism is unable to synthesize the vitamins; consequently our diet should contain satisfactory quantity of vitamins. Deficiency of vitamins (avitaminosis) results in specific diseases, such as skorbut, a typical consequence of vitamin C deficiency.

Due to their chemical heterogeneity, vitamins are divided on the basis of solubility into fat-soluble and water-soluble vitamins. The fat soluble vitamins include vitamins A, D, E (tocopherol), and K. Among the water-soluble vitamins the group B is the major one. It includes vitamin B_1(thiamine, aneurine), vitamin B_2 (riboflavin, lactoflavin), niacin (nicotinic acid, nicotinamide, vitamin B_3), vitamin B_6 (pyridoxine, pyridoxal, pyridoxamine), pantothenic acid (vitamin B_4), biotin (vitamin H), vitamin B_{12}, and

vitamin B_{15} (pangamic acid). Additional water soluble vitamins are the vitamin C (ascorbic acid) and the vitamin U. In addition to vitamins a significant number of compounds is known which are essential for normal function of organism, however they are partly synthesized by organism or their exact role is not fully clarified. Such compounds are e.g. choline, lipoic acid, mesoinosite, carnitine (vitamin T), essential fatty acids (vitamin F), and flavonoids (vitamin P).

In the framework of this chapter the basic chemical properties of vitamins, their stability (primarily heat stability and sensitivity to oxidation), occurrence in foods and daily requirements of vitamins are discussed.

1. Introduction

Vitamins are defined as organic compounds which are required for the normal growth and maintenance of life of animals, including man, who, as a rule, are unable to synthesize these compounds. Thus vitamins must be obligatory constituents of our food. The deficiency of vitamins is usually characterized by the occurrence of specific symptoms. Each vitamin is required for specific metabolic reactions within the cells. When a particular vitamin is omitted from the diet, the respective biochemical reaction in which the vitamin participates cannot take place and specific symptoms of an *avitaminosis* are produced. In majority of cases the vitamin deficiency is not absolute, but rather marginal, leading to non specific symptoms such as loss of appetite, reduced growth and nutrient utilization.

Detection of vitamins and revealing of their necessity for normal function of human organism is a result of investigations at the end of 19-th and beginning of the 20-th century which were connected with *beri-beri*, a disease occurred in the Far East countries. Casimir Funk described a compound the intake of which eliminated this disease. Bering in mind that this compound contained nitrogen, a typical atom of organic compounds named amines and amides, and also its vital importance Funk gave it the name "*vitamin*". Later several other food constituents were found having similar biological role and the name vitamin became the common name of the group of these biologically active compounds.

Before the discovery of their chemical nature the vitamins were called simply by letters of the alphabet. Although the designation by letters is generally still accepted, for some vitamins the use of chemical name or trivial names is also common.

The vitamins are divided on the basis of their solubility properties into fat-soluble and water-soluble vitamins. The fat soluble vitamins include vitamins A, D, E, and K, while the members of the B group and vitamin C are classified as water soluble vitamins. In the early years of vitamin research only one vitamin B was known. Later research revealed that vitamin B was not a single compound, but a mixture of several vitamins. The newly detected compounds were designated with subscripts to letters (e.g. vitamin $B_{1,}$ B_{12} etc.).

There are certain compounds which are not vitamins by themselves but function as vitamins after undergoing a chemical change. After their ingestion with the diet these

compounds are converted in the cells of the body to vitamins. These are precursors of vitamins and are called *provitamins.*

Certain compounds similar in structure to the vitamins, mainly B vitamins, can replace the vitamin in given biochemical processes and so prevent the true vitamin to fulfill its function. Compounds of this type which resemble particular vitamin – the majority are synthetic substances- compete with the vitamin within the human organism and are termed *antivitamins.*

2. Water-soluble Vitamins

2.1. Vitamin B_1 (Thiamine, Aneurin)

This vitamin is widely distributed over the plant kingdom and is synthesized by higher plants. Cereal seeds are good sources of this vitamin. However due to the fact that thiamin occurs in the outer coats of the kernels, polished rice or white wheat flours contain only low quantities of this vitamin. Because of its essential nature, vitamin B_1 is present in small amounts throughout the normal animal organisms. Thus tissues of heart, liver, and kidneys contain higher concentrations than those of muscles. Among foods of animal origin milk and egg contain substantial amounts.

From chemical point of view, thiamin is an organic compound which contains two ring systems, a pyrimidine ring and a thiazole ring, which are connected with each other trough a methylene bridge (Fig.1.). Thiamin can be synthesized by a number of different procedures and the commercially available pure material (used in pharmaceutical products or for enrichment of food and feed with vitamins) originate generally from syntheses. In living organisms thiamin may occur in bound forms, mainly as constituent of coenzymes.

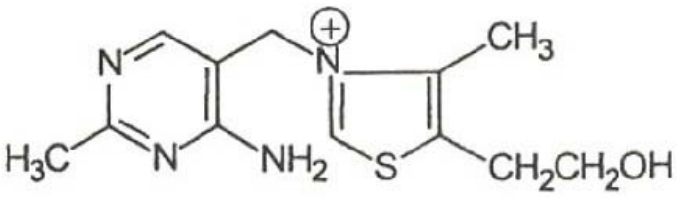

Figure1: Vitamin-B_1

Thiamin is essential for the maintenance of a functionally normal nervous system. In thiamin deficiency loss of appetite, unusual susceptibility to fatigue, and gastrointestinal disturbances are common. As a result, diminished food intake occurs, which in turn is the case of the failure to synthesize and deposit fatty acids. The disease of advanced vitamin B_1 deficiency are known as polyneuritis and beri-beri which are caused by injury to nerve tissues and which manifest themselves by such symptoms as lameness, disturbance of the motor and sensory nerves, hypertrophy of the heart, and finally death from heart failure.

The human requirements for thiamine are in the order of 1-3 mg per day (0.5mg per 1000 calories). The necessary daily intake is a function of the type of food supplied

(carbohydrates increase, fats, proteins, and alcohol decrease the amount of vitamin $B_{1\ needed}$). The intensity of the metabolism (heavy physical work), the outside temperature and other factors may also influence the requirement.

The stability of thiamine is strongly dependent on the type of food. Generally its stability is lower in weakly acidic media and higher in neutral or alkaline media. Intensive heat treatment at higher temperatures causes degradation of this vitamin. The losses of thiamin during processing (slicing and washing, pasteurizing, cooking, frying, extrusion and baking) range from 10 to 60%. Storage at low temperatures (2-6 ^{o}C) for 12 months causes negligible losses.

2.2. Vitamin B_2 (Riboflavin, Lactoflavin)

The alternative name of this vitamin is connected with its yellow color (*flavus)* and its occurrence in milk. Riboflavin is widely distributed over the entire animal and plant kingdom, but occurs in significantly lower concentrations than thiamine. Relatively good dietary sources include heart, liver, kidney, eggs, milk, yeast, green vegetables, and germinated seeds.

Chemically, riboflavin is a dimethyl derivative of isoalloxazine and has a ribose side chain (Fig.2.). This vitamin is synthesized commercially by a

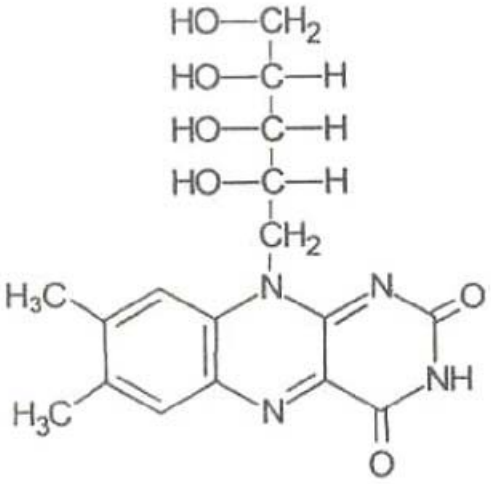

Figure 2: Vitamin-B_2

number of different procedures. Primarily for the use as feed supplement, concentrates are prepared from the yeast, from bacterial growth on the whey, and from distillers' slops of anaerobic fermentations.

Human requirements of riboflavin have been estimated as approximately 0.6-0.7mg per 1000 calories, and in clinical practice 2-3 mg are given daily. Riboflavin deficiency symptoms of human beings include *cheilosis,* a cracking of lips and the corners of the mouth. The tongue becomes purplish or of magenta color and a flattening of papilla (glossitis) is observed. The symptoms of riboflavin deficiency are relatively difficult to

observe in humans. In rats, in which deficiency can be produced by experiment, growth is impaired, changes occur in the lens of the eye leading to blindness, nerve degeneration is observed, and there is impaired reproduction. Vascular invasion of the cornea belongs also to the group of symptoms which all together or separately occur in *ariboflavinosis* in humans.

Riboflavin is thermostable and unaffected by atmospheric oxygen. The pH of media influences its stability. In strongly acid solution riboflavin is stable, but at higher pH-s (alkaline solution) is unstable. Due to its thermostability, losses of riboflavin during processing of different foods are negligible. Exposing riboflavin-containing foods to light causes decomposition of riboflavin.

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Bibliography

Brody,T. (1994) *Nutritional Biochemistry.* Academic Press, San Diego, New York, Boston, London, Sydney, Tokyo, Toronto.(A book intended for students of nutrition and related biological sciences, as well as premedical and nursing students)

Fennema,O.R.(1985) *Food Chemistry*. Marcel Dekker Inc., NewYork-Basel. [A widely used book for students and researchers. From point of view of vitamins its value is that the stability and chemical changes of vitamins are exhaustively treated]

Biographical Sketch

Dr Natalia Cicic-Lásztity Ph.D. is a specialist in pediatrics at the Heim Pal Hospital in Budapest Hungary. She received her M.Sc. degree from the University of Belgrade (Faculty of Medicine) in 1990. Dr Cicic-Lasztity worked till 1997 in the Pediatric Clinic of Semmelweis University of Medical Sciences in Budapest and obtained a degree of specialists in pediatrics. From 1998 to 2002 she took part in research program of the Hungarian Institute of Health and Nutrition connected with clinical nutrition of patients with heavy pancreatitis. She received her Ph.D. degree in clinical nutrition in 2005. Dr Cicic-Lasztity published several papers in scientific journals mainly in the field of clinical nutrition. She also participated in several national and international scientific events. Her present major interest is enteral and parenteral nutrition.