Chapter 1

VITAMINS AND RELATED COMPOUNDS VIA MICRO-ORGANISMS: A BIOTECHNOLOGICAL VIEW

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1 HISTORICAL

The start of the history of vitamins can be traced back to 400 BC, when Hippocrates reported that eating liver could cure night-blindness. Much later, in the 16th century, the therapeutical effects of lemon juice against scurvy or scorbut became known; scorbut had *inter alia* caused the loss of 100 crew members on Vasco da Gama’s journey around Cape Hope. The English ship doctor James Lind studied this disease further and described in 1757 in his book *A Treatise of Scurvy* the beneficial effect of eating fresh vegetables and fruits in preventing it. For another nutritional deficiency disease (already mentioned in 1762 by Oviedo), the Italian doctor Francesco Frapoli used the name pellagra (*pella* = skin; *agra* = rough). In the 19th century in Japan, the Hikan child disease (keratomalacia and xerophthalmia) was successfully treated by including ale-fat, cod liver oil or chicken liver in the diet. Trousseau discovered that cod liver oil and also, direct sunlight, had a curing effect on rickets, a disease already well described by Whistler in 1645. In the Far-East, when hulled rice was replaced by dehulled or polished rice, a sharp increase in the occurrence of beriberi was observed. In 1897 Eijkman observed that poultry fed with polished rice developed polyneuritis, a disease very similar to human beriberi. This disease could also be prevented and cured by feeding rice and the silver fleece of the rice kernel. Grijns in 1901 hypothesised that beriberi was caused by a protecting factor, which was obviously lacking in dehulled rice. We now know that all these diseases are a result of nutritional vitamin deficiencies (Machlin, 1984).

Around 1910, Hopkins in the UK and Osborne & Mendel in the USA initiated modern vitamin research and developed a theory, stating that diseases such as scurvy, pellagra, rickets, beriberi, etc., are the result of a lack of certain essential food components. The Polish chemist Casimir Funk isolated in 1912 from rice bran a beriberi-preventing compound, displaying chemical
properties of an amine; this led him in 1912 to coin the name vitamin for this type of compounds.

In 1913, McCollum & Davis demonstrated a liposoluble factor A in butter fat and egg yolk, and in 1915, a water-soluble factor B was found in wheat-germ. It was Drummond in 1920 who named the fat-soluble factor, vitamin A; the water-soluble anti-beriberi factor was named vitamin B; the water-soluble anti-scorbut factor vitamin C. In 1925, the fat-soluble anti-rickets factor was named vitamin D. After 1930, discovery and isolation of several other vitamins followed quickly and their structure, nutritional and chemical properties and synthesis were studied in great detail in the following decades.

These aspects of vitamins and growth factors are compiled in several excellent standard references (Goodwin, 1963; Sebrell & Harris, 1971; De Luca, 1978; Machlin, 1984; De Leenheer et al., 1985; Diplock, 1985; Chytil & McCormick, 1986; Adrian, 1988; Friedrich, 1988).

2 VITAMINS: WHAT'S IN A NAME?

Vitamin nomenclature was initially based on the use of letter symbols, alphabetically arranged to time of discovery. Soon, it appeared that one-letter named vitamins were multiple complexes, and this led to the addition of an index to the original letters (B₁, B₂, ...). Often, when the function of the vitamin became known, an appropriate letter symbol was chosen, i.e. vitamin K, with K as the first letter of the German word Koagulation; other names reflected deficiencies, i.e. aneurin (B₁) for anti-polyneuritis vitamin; vitamin PP = "pellagra-preventing" vitamin. Letter names or trivial names are generally more in use rather than the IUPAC names. The division into fat- and water-soluble vitamins as introduced by McCollum & Davis, is still universally applied.

A listing of well-recognised vitamin compounds is presented in Table 1.

From a chemical point of view, vitamins are a very heterogeneous mixture of compounds, yet they can be considered as a single group, since they are all organic compounds which are essential for a healthy development of humans and animals and need to be present in their food, since their body is not able at all—or not sufficiently able—to synthesize them. Indeed, certain vitamins can be formed partially or indirectly in the body:

(a) compounds—often called provitamins—with no apparent vitamin activity can be converted within the body into a vitamin, i.e.

β-carotene (in vegetables, fruits) \( \rightarrow \) vitamin A
tryptophan (in protein-rich food) \( \rightarrow \) nicotinic acid (niacin)
7-dehydrocholesterol (in skin) \( \rightarrow_{UV} \) vitamin D₃ (cholecalciferol)

(b) other vitamin compounds are formed by the intestinal bacterial flora i.e. vitamin K, some B-vitamins, i.e. B₁₂, etc.

Most vitamin compounds thus have to be provided via daily food/feed intake.