Is there a biochemical basis for 'nutrient need'?

The term 'nutrient need' (or 'requirement') is used to refer to the minimal amount of an essential nutrient that is needed to prevent a frank deficiency. An intake lower than 'need' causes a deficiency, and a higher one prevents deficiency. This implies that there is a sharp distinction in physiology between 'normal health' and a deficiency. Thus, at the biochemical level, 'need' would correspond to abrupt changes in metabolic processes.

However, mathematical modelling of nutrient dose-response relationships does not identify any parameter with 'nutrient need'[1]. Furthermore, the concept of 'nutrient need' is used as the basis for nutritional recommendations and, therefore, it would appear that recommendations are based on an oversimplified model of nutrient dose-response relationships.

Thus, the idea of 'nutrient need' gives the false impression that exact amounts of nutrients are required daily, and that larger amounts are of no physiological significance, except for providing passive reserves. However, this is not the case. Larger intakes result in higher concentrations, may result in higher reaction rates and, consequently, may affect physiological processes.

For example, the 'need' for vitamin C is about 10 mg/day, a quantity that will provide protection against scurvy. A serum concentration of 1 mg/l is maintained by ingesting 10 mg/day of the vitamin; 60 mg/day (the recommended intake[2]) maintains a serum concentration of 6 mg/l (Ref. 3). However, high intake levels (1-10 g/day) increase the vitamin concentration to around 15-25 mg/l (Ref. 4). Several vitamin-C-dependent reactions, such as collagen synthesis, appear to be saturated with low levels of the vitamin (at the biochemical level, scurvy is attributed to decreased collagen synthesis), yet some non-enzymatic reactions exhibit first order kinetic behaviour and, therefore, proceed faster with higher concentrations of the vitamin (e.g. reaction with superoxide[5,6]). It has been suggested that a vitamin C intake of 150 mg/day may provide better protection against reactive peroxy radicals[7]. Furthermore, vitamin C reacts with nitrite and thereby decreases the production of carcinogenic nitrosamines. The chemical mechanism of this reaction is quite complicated, yet there is no reason to suppose that 10 or 60 mg/day would be an adequate or optimal level for this effect[8].

Similar problems arise when other vitamins are considered. The B vitamins serve as cofactors for many enzymes. At the biochemical level, an obvious possibility would be to correlate requirement with enzyme parameters, such as the degree of saturation by the cofactor, or the enzyme activity. However, there are scores of enzymes in different tissues that use B vitamins as cofactors. Therefore, it is difficult to determine the appropriate enzymes to measure.

The recommended daily allowance for pyridoxine is 2 mg/day (Ref. 2). When the intake of pyridoxine is increased from the amount obtained from a normal diet (~2 mg/day) to 100 mg/day, the saturation of erythrocyte aspartate aminotransferase is increased from 72% to 97%, and the total enzymatic activity is increased to 2.1 times the basal level[9]. Several other enzymes in different tissues may show a similar dependency on the intake level. High enzyme activity may be beneficial in some instances, even if normal life is not affected. For example, in some people, the 'Chinese Restaurant Syndrome' may result from a large intake of glutamate. This syndrome may be prevented by ingesting 50-200 mg/day of pyridoxine, which apparently saturates an essential enzyme and increases the metabolism of the excess glutamate[10]. The critical enzyme is not known, but pyridoxine is a common cofactor of enzymes in amino acid metabolism.

The concept of 'optimal intake' has been suggested as a basis for a more satisfactory approach to nutrition than the nutrient need approach. Optimal intake levels would, by definition, optimize specific reaction rates in the body and, accordingly, result in best possible health[11-15]. Thus, a frank deficiency corresponds to very slow reaction rates but, in contrast to the implications of the 'nutrient need' concept, there is no sharp distinction between deficiency and 'normal health'. In fact, the concept of optimal intake conflicts with the nutrient need approach. The recommended levels are not optimal and they are not intended to be; their aim is solely to prevent deficiency[2,12,13].

Traditional recommendations may be of great value in evaluating food quality. However, they should not be used as a basis for claiming that amounts in excess of the recommendations will not have any physiological effects. Lack of a frank deficiency, *per se*, does not necessarily reflect optimal metabolism. Sometimes, the optimum levels may be markedly higher than the recommended levels[3,13,16].

Harri Hemilä
Institute of Biotechnology, University of Helsinki, Valimotie 7, 00380 Helsinki, Finland.

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