USANA Clinical Research Bulletin

No. 15 USANA Health Sciences September 5, 2008

Comparative Absorption of Water Soluble Vitamins from Five Supplements

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Introduction

Nutrient bioavailability is an important characteristic of nutritional supplements. It is a measure of the extent to which the nutrients in a supplement are absorbed by the body and delivered to the blood stream. Many factors affect the absorption of a given nutrient from a given supplement (see Discussion), but in general, relatively high bioavailability is desirable because absorption is a prerequisite for eventual activity and benefit. As such, quality supplements are designed to provide optimal nutrient bioavailability and absorption.

That said, claims of high bioavailability have been misused in the supplement industry. Some companies tout that their "revolutionary formulas" promote "exceptional absorption," but then they provide no comparative data to substantiate their claims. Moreover, such claims seldom draw the important distinction between percent bioavailability and total absorption.

Consider the following example. Company A might state that their form of vitamin C is 80% bioavailable, meaning that the average person should absorb approximately 80% of the vitamin C from a dose of Company A's product. If that product contains 100 mg of vitamin C, then the average person would absorb a total of 80 mg from a given dose. In comparison, Company B's formula might provide vitamin C in a form that is only 70% bioavailable. But if the dose of vitamin C in that product is 500 mg, then the average person would absorb a total of 350 mg of vitamin C, a significantly higher absolute absorption. Clearly total absorption is the key feature, and if all other factors were equal (including price), Company B's formula would be preferable.

The purpose of this study was to compare the total absorption of several water soluble vitamins as delivered by the following five multivitamin / multimineral formulas: the USANA Essentials in tablet form, an encapsulated formula based on vegetable and fruit juice powders, a gel-based formula supplying nutrients in a soluble gum suspension, a phytonutrient formula delivered in caplet form, and a mass market "one-per-day" tablet (1).

Methods

This study followed a randomized crossover design involving 10 healthy subjects. Regular intake of all dietary supplements was discontinued ten days prior to the start of the study. In addition, volunteers were asked to refrain from structured physical activity on each study day. Each person took a full daily dose of each of the five products in random order on five separate days. The products were taken first thing in the morning with a standard meal (plain bagel and cream cheese) after completing a 10-12 hour overnight fast. Blood samples were taken at baseline (prior to supplementation) and again at 1, 3, and 7 hours after supplementation. Subjects were fed the same standard meal for lunch, and they were allowed unlimited water over the course of the day. No additional food or beverages were allowed until after the final blood collection.

All blood samples were analyzed using standard methods for vitamin C, riboflavin, vitamin B6, and Plasma Antioxidant Reserve (PAR), a measure of overall antioxidant status (2). Curves showing the blood concentrations of these factors over the seven-hour study period were plotted, and the Areas Under the Curves (AUC) were calculated to provide measures of total nutrient absorption. The average AUC was calculated across the 10 subjects for each nutrient as delivered by each product, and differences between products were tested for statistical significance.

Results

The absolute absorption of the three water soluble vitamins varied markedly between products, and in all cases the USANA Essentials delivered higher levels of these nutrients to the bloodstream per daily dose than did the other products (Figures 1-3). AUC measurements showed that the Essentials delivered about 15% more vitamin C to the bloodstream than did the fruit and vegetable juice powder product (the second most effective formula with respect to vitamin C). Moreover, the Essentials delivered 3-4 times more vitamin C to the bloodstream than did the "one-per-day," gel-based, and phytonutrient formulas. Similar patterns were found in the comparisons for riboflavin and vitamin B6, with the USANA Essentials generally outperforming the competitors' products by 2-10 fold or more. With respect to PAR, all products boosted this measure of antioxidant status, but again the USANA Essentials outperformed the other products by a factor of 1.5-3.0 fold (Figure 4). In almost all cases, the differences in absolute nutrient absorption between the USANA Essentials versus the other products were statistically significant ($p \leq 0.05$).

Discussion

As noted previously, many factors affect the absolute absorption of a given nutrient from a given supplement formula. These include the amount of that nutrient in the formula, the form of the nutrient in the formula, the amounts of other (competing) nutrients in the product, the degree and speed with which the product disintegrates in the gut, whether or not the product is taken with a meal, the presence of factors that can enhance nutrient absorption, and more.

We believe that one of the most important factors underlying the differences found in this comparative study was dose; i.e. the presumed fact that a daily dose of the USANA Essentials contained higher amounts of vitamin C, riboflavin, vitamin B6, and total antioxidants than did the other products. We say "presumed fact" because two of the products did not provide complete label information on nutrient amounts. That said, several of these competing products claim that they do not need to provide higher nutrient doses because their formulas are so much more bioavailable. Our results call these claims into question. The USANA Essentials clearly delivered higher amounts of the four tested nutrients to the bloodstream than did the competing products. We found nothing to suggest that nutrients provided in plant-based forms or exotic gel-based formulas possess superior bioavailability. Moreover, we found no evidence to suggest that these more exotic formulas provide superior nutrient bioavailability and absorption (percent and total) when compared to a relatively inexpensive, mass market "one-per-day" type product.

In conclusion, supplement users need to exercise caution when interpreting claims of high nutrient bioavailability. They need to demand evidence to support those claims, and they need to draw an important distinction between percent bioavailability and total nutrient absorption. At the end of the day, it is the absolute levels of nutrients absorbed by the body that define the effectiveness of a product.

References and Notes

(1) The term "one-per-day" is used here in a generic sense and does not refer to a specific product or brand of products.

(2) Rabovsky, A, J Cuomo, N Eich. 2006. Measurement of plasma antioxidant reserve after supplementation with various antioxidants in healthy subjects. Clin Chim Acta 371: 55-60.

Figure 1-4. Absolute absorption for vitamin C, riboflavin, vitamin B6, and antioxidants (as measured by Plasma Antioxidant Reserve - PAR) from daily doses of five multivitamin / multimineral supplements. Bars represent the means of Area Under the Curve measures of blood nutrient levels for 10 subjects during the 7-hour test periods. Standard errors are indicated. Bars are labeled as follows. "USANA" denotes USANA Essentials; "Juice" denotes a product based on vegetable and fruit juice powders; "Gel" denotes a product formulated with a gel-based delivery system; "Phyto" denotes a phytonutrient-formula, "1/Day" denotes a mass market one-per-day type formula.

Figure 1. Vitamin C Comparison

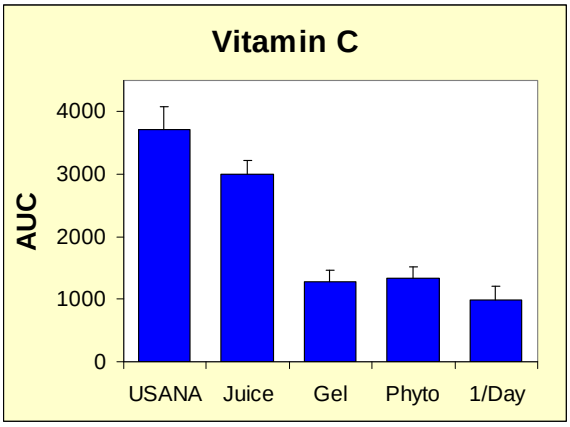

Figure 2. Riboflavin Comparison

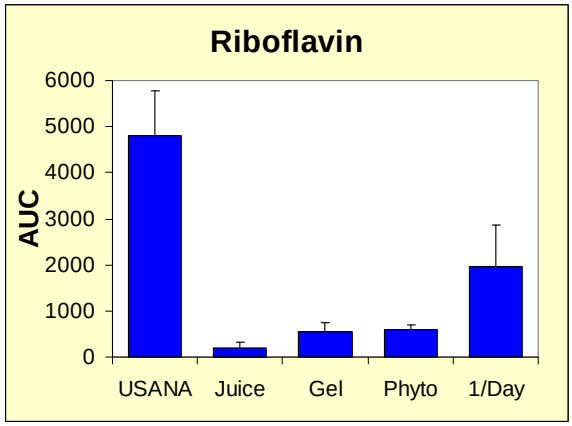

Figure 3. Vitamin B6 Comparison

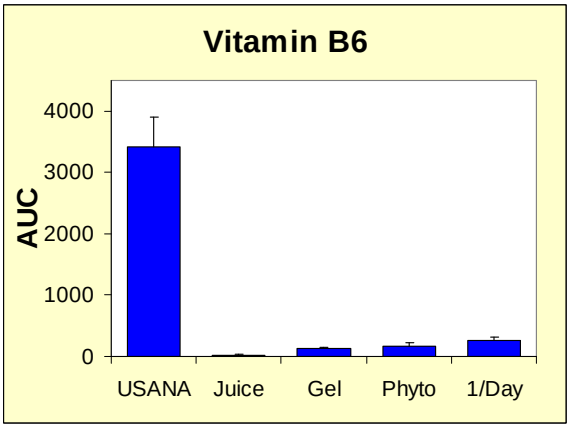

Figure 4. PAR Comparison