Analytical Antioxidant Content in Selected Adult Multivitamin/mineral (MVM) Supplements

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DSID Dietary Supplement Ingredient Database A U.S. Government Initiative

Abstract 700.12

Intakes of antioxidants beta-carotene, vitamins C and E, and selenium can be greater from supplements than from foods, so determination of actual levels in MVMs is important if accurate estimates of exposures are to be possible. We assessed frequency of reported percent Daily Value (%DV) levels in MVMs using NHANES 2001-02 data. The top 3 %DV levels represented 70 to 80% of weighted frequency of consumption for each nutrient. The most frequently reported % DV levels were 100 and 200 for beta-carotene, vitamins C and E, in addition to 20 for beta-carotene, 833 for vitamin C, 333 for vitamin E, and 28, 285 and 100 in ranked order for selenium. Six MVMs were randomly selected at each of the 3 DV levels (n=18) for each nutrient and analyzed to ascertain actual content. The standard deviation for beta-carotene content compared to labeled DV values was 14, 39, and 54% at DV levels of 20, 100, and 200% respectively. Analytical values for vitamin C were within 8% at all 3 DV levels. Analytical values for natural vitamin E were 39% above label and for synthetic vitamin E were 14.6 and 6.7% above label at 100 and 200% DV label levels respectively. MVMs containing dl-α tocopheryl as the synthetic vitamin E ingredient had analytical values closer to label than MVMs containing natural d-α tocopheryl. Analytical results for selenium were 21-26% higher than label at all 3 DV levels. Preliminary results for these 4 nutrients indicate that differences between label and analytical values vary by nutrient. Funded by USDA & ODS/NIH Y1CN5010.

DSID Overview

The Nutrient Data Laboratory (NDL) of the Beltsville Human Nutrition Center, ARS/USDA, is collaborating with the Office of Dietary Supplements at the National Institutes of Health, the National Center for Health Statistics at the Centers for Disease Control and Prevention, and the National Institute of Standards and Technology (NIST) to develop the Dietary Supplement Ingredient Database (DSID), an analytically supported database of dietary supplement ingredient information. The primary use of this database will be to support research on the US intake of nutrients from supplements and food.

The goals for the DSID are to:

(a) develop reliable estimates of ingredients in Dietary Supplements (DS);
(b) assess variability and possible overages when comparing analyzed nutrient levels to labeled levels;
(c) release and maintain a publicly available on-line dietary supplement composition database.

Multivitamin/mineral (MVM) products were chosen for the initial study because these were the most commonly reported dietary supplements in the 2001-02 National Health and Nutrition Examination Survey (NHANES).

Introduction

Epidemiological studies indicate that a high consumption of fruits and vegetables, which are rich in antioxidants, is associated with delayed aging, prevention of cardiovascular diseases, and a lower risk of cancer[1].

NDL's objectives in this study are:

•to assess common % Daily Value (DV) levels and their frequency of use for the antioxidants beta-carotene, vitamin C and E, and selenium in adult MVM supplements reported in NHANES 2001-02[2];

• to evaluate the systematic relationship between label value and analyzed value for these antioxidants in adult MVM; and

•to evaluate variability of antioxidants in MVM products as a part of a larger study of nutrient composition of dietary supplements.

Methods and Materials

NHANES 2001-02 dietary supplement questionnaire data files and demographic files were used to determine the reported prevalence of beta-carotene, vitamins C and E, and selenium in adult MVM products. Numbers of supplements, respondents, and weighted frequencies of use for all nutrients were summed at each labeled % DV level. In the NHANES 2001-02, more than 1800 adult respondents, representing about 35% of the US adult population, reported taking at least one MVM product during the previous month. Among the total of over 2200 different supplements reported, 541 products (24%) were adult MVM formulations (defined as containing 3 or more vitamins). Table 1 shows the 3 most commonly reported label %DV levels and the number of products reported at each specific level for each nutrient. The most common %DV level was 100 for vitamins C and E. For example, a total of 142, 40, and 39 different MVMs contained vitamin E at 100, 200, and 333% DV levels respectively.

Table 1: Most Frequently Reported % DV Levels for 4 Antioxidants from Adult MVM Products Reported in NHANES 2001-02

Nutrient	%DV	% Weighted Frequency of Use	Nutrient Quantity	Unit	Number Of Supplements Reported
Beta-carotene	20	59.5	0.3	mg	43
Beta-carotene	100	5.0	1.5	mg	15
Beta-carotene	200	4.4	3	mg	10
Vitamin E	100	49.0	13.5	mg	142
Vitamin E	200	15.0	27	mg	40
Vitamin E	333	6.4	45	mg	39
Vitamin C	100	52.9	60	mg	124
Vitamin C	200	11.8	120	mg	41
Vitamin C	833	3.1	500	mg	34
Selenium	29	50.1	20	mcg	51
Selenium	286	12.8	200	mcg	37
Selenium	100	9.3	70	mcg	25

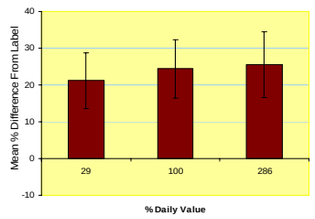
For each nutrient, a total of 18 MVM products (6 products at each of the common %DV levels) were randomly selected for the analysis from the list of reported supplements. Two products at each %DV level were randomly chosen and sent for analysis with quality control materials on 3 independent days. Table 2 shows the study design for beta-carotene, vitamin C, E and selenium. Vitamins C and E and beta-carotene were analyzed by a qualified contract laboratory using HPLC. Selenium was analyzed using the hydride generation method and measured by atomic absorption spectroscopy. Mean and SEM of the percent difference between analytical value and label value were calculated using SAS 9.1(SAS Institute Inc., Cary, NC, USA).

Table 2: DV Study Design for MVM Analysis of beta-carotene, Vitamins C and E, and Selenium

Laboratory Day 1	Laboratory Day 2	Laboratory Day 3
%DV Level 1: MVM Product 1 MVM Product 2	%DV Level 1: MVM Product 3 MVM Product 4	%DV Level 1: MVM Product 5 MVM Product 6
%DV Level 2: MVM Product 7 MVM Product 8	%DV Level 2: MVM Product 9 MVM Product 10	%DV Level 2: MVM Product 11 MVM Product 12
%DV Level 3: MVM Product 13 MVM Product 14	%DV Level 3: MVM Product 15 MVM Product 16	%DV Level 3: MVM Product 17 MVM Product 18
2 Random duplicates and 2 MVM control materials	2 Random duplicates and 2 MVM control materials	2 Random duplicates and 2 MVM control materials

Results and Discussion

Figure 1: Analytical Selenium as % Difference From Label Value at 3 Major % DV Levels



Figures 1-3 show the mean percent difference between label and analytical values and the standard error of the mean (SEM) for selenium and vitamins C and E. beta-carotene had some methodology and sample preparation issues; therefore, data for this nutrient have not been finalized. The results for beta-carotene will be presented in a later report.

Figure 1 shows the mean percent difference between label and analytical values for selenium at the 3 major %DV levels. At higher %DV levels, the percent difference from label and standard errors were slightly higher. The average percent difference from label was +21, +24 and +26 at the % DV levels of 29, 100 and 286 respectively. The SEM were 7.5, 7.9 and 8.9 at these 3 levels respectively.

Figure 2: Analytical Vitamin C as % Difference From Label Value at 3 Major % DV Levels

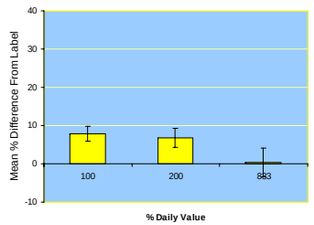
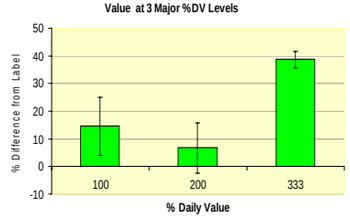


Figure 2 shows analytical vitamin C results as the mean % difference from label at the 3 major %DV levels. Across all %DV levels, the analytical values were less than 8% above label values. Products at the highest level, 833% DV, were closest to the label with a mean difference of 0.4% above label. The SEM were 1.9, 2.5 and 3.8 at 100, 200 and 833% DV levels respectively.

Figure 3: Analytical Vitamin E as % Difference From Label Value at 3 Major %DV Levels



Analytical and label Vitamin E values were compared using the FDA's labeling guideline for converting the quantity of vitamin E from IU to mg (IU *0.9=mg for synthetic, IU*0.67=mg for natural). It is interesting to note that in this study, all MVM products (n=6 at each level) labeled at 100 and 200% DV levels contained synthetic vitamin E (all-rac or dl-α-tocopherol) and all products (n=6) labeled at 333% DV level contained natural vitamin E (r,r,r- or d-α-tocopherol). The means of percent difference between analytical and label values for products containing synthetic vitamin E were 14.6 and 6.7% above label at the 100 and 200% DV levels respectively as shown in **Figure 3**. The analytical values for products containing natural vitamin E averaged 39% above label at the 333% DV level. The SEM were 10.9, 9.1 and 3.0 at 100, 200 and 333% DV levels respectively.

Conclusions

- These %DV study results show that analytical values for vitamin C were consistently close to the labeled value---between 0-8% above label with SEM of 7.5-8.9.
- The analytical values for selenium averaged 21-26% above label with SEM of 1.9-3.8.
- The analytical values for natural vitamin E averaged 39% above label and synthetic vitamin E values averaged 14.6 and 6.7% above label at 100 and 200% DV levels, respectively.

References:

1. Weisburger JH. 1991. Nutritional approach to cancer prevention with emphasis on vitamins, antioxidants and carotenoids. American Journal of Clinical Nutrition. 53: S226-S237.
2. Http://www.cdc.gov/nchs/nhanes/ Accessed May 2005.