

Caffeine, Theobromine and Theophylline Content of Commonly Purchased Weight-loss and Sports Performance-enhancing Dietary Supplements

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Abstract

Consumers' intake of caffeine occurs through dietary supplements as well as traditional food and beverage items. To better identify overall consumer exposure to caffeine, 63 products commonly marketed for weight loss or sports performance were selected from 4 sales channels. Caffeine-containing dietary supplements were selected when labels listed one or more of these ingredients: caffeine, guarana, yerba mate, cocoa, kola, green tea and citrus aurantium. Samples were analyzed with blinded standard reference materials for caffeine, theobromine, and theophylline content by high performance liquid chromatography (HPLC) analysis of caffeine from the use of the supplements was calculated using claimed values and analytical values along with maximum recommended label amounts. Laboratory analysis of 63 products showed a range of 0 - 204 mg caffeine/pill. Among 63 products analyzed, 33 had a label claim for caffeine content. Of these, 88% had a mean analyzed value within 20% of the claimed content, with 20 products above and 8 below the claim level. If taken at maximum recommended label amounts, 55% of the products provided >200 mg caffeine/day. In these products, theobromine levels ranged from 0 - 15.7 mg/pill and theophylline levels ranged from 0 - 2.2 mg/pill. Funded through FDA and ODS/NIH Y4-HV-0051.

Introduction

The Nutrient Data Laboratory (NDL), US Department of Agriculture (USDA) publishes food composition data that includes levels of caffeine in foods and beverages.¹ The USDA and the National Center for Health Statistics (NCHS) provide food consumption data that allow estimation of caffeine intake from foods for the US population. However, no validated analytical data is available for caffeine levels in dietary supplements. As part of a collaboration between NDL, NCHS and the Office of Dietary Supplements (ODS) to develop analytical values for an ingredient database of dietary supplements, dietary supplement products were analyzed for caffeine.

Approximately 60 dietary supplements sold in supermarkets, drugstores, health food stores, catalogs, the Internet and through multi-level marketers were purchased and analyzed for caffeine, theobromine and theophylline. Three lots of each product were purchased over a period of 9 months. Sports performance-enhancing and weight-loss products were identified as most likely to contain caffeine.

An independent laboratory that specializes in analysis of foods and dietary supplements was chosen to analyze the products for caffeine. Rigorous quality control measures, including the use of Standard Reference Materials (SRMs), were implemented.

Methods and Materials

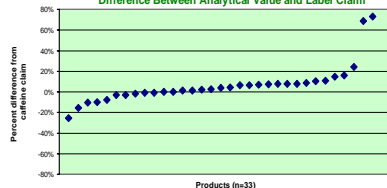
The following ingredients and their synonyms were identified as containing caffeine, theobromine or theophylline: coffee, cocoa, cacao, chocolate, *Colanida*, green tea, black tea, *Camellia sinensis*, yerba mate, mate, *Ilexparaguarensis*, kola nut, kola, kola nut, guarana, *P. Cupana*.

The sample of products was drawn according to retail channel, stratified by 2001 market data from the Nutrition Business Journal¹. Products were chosen based upon the market share for four categories: 1) health food/natural foods and vitamin stores (30.1%, n=18); 2) traditional supermarkets, grocery stores, drug stores and mass merchandisers (25.4% n=16); 3) multi-level marketers and direct (internet, catalog) sales (41.3% n=27); and 4) practitioners (3.2% n=2). For the categories with n>2, top-selling products were identified to be sampled. Additional samples were randomly selected. Products were chosen only if they contained at least one of the ingredients listed above.

Samples of each product were sent to an independent laboratory for high performance liquid chromatography (HPLC) analysis of caffeine, theobromine and theophylline. Each batch of samples included National Institute of Standards and Technology (NIST) SRMs and two products with blinded duplicates. Caffeine intake from each supplement was calculated using claimed and analytical values using the recommendations for maximum number of pills per serving and pills per day on the product label.

Caffeine Results

Figure 1. Dietary Supplement Caffeine Levels: Difference Between Analytical Value and Label Claim



Laboratory analysis of these products showed product means ranging from 0.05 - 204 mg caffeine/pill. Of the 33 products with a quantifiable label claim for caffeine, 88% showed a mean analytical value within 20% of the claim (Figure 1).

Calculations of caffeine intake per pill, per serving and per day (using the maximum recommendations on each product label) based on analytical means are shown in Figures 2 and 3. Since label instructions for different products directed consumers to take a range of pills (1-4 pills per serving, 1-4 times per day), these three measures (mg/pill, mg/serving and mg/day) were used to compare caffeine intake among products.

In Figure 2, comparing products without caffeine claims, the mean analyzed level of caffeine in mg/pill was 38.8 (range: 0.05-143); in mg/serving was 67.9 (range: 0.05-219); in mg/day was 151 (range: 0.15-622). In Figure 3, comparing products with caffeine claims, the mean analyzed level of caffeine in mg/pill was 91.2 (range: 27-204); in mg/serving was 156.4 (range: 43-373) and in mg/day was 352.8 (range: 96-829).

Figure 2. Products Without Caffeine Claim: Analyzed Caffeine level per pill, per serving and per day

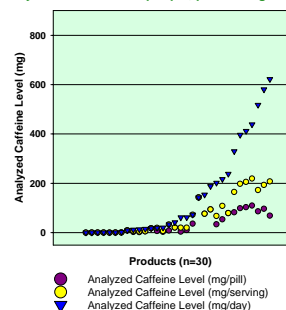
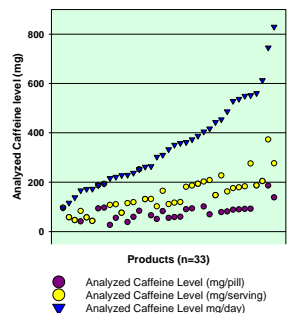
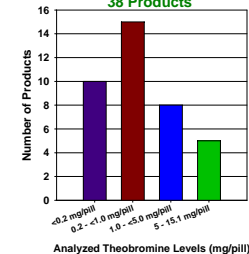


Figure 3. Products With a Caffeine Claim: Analyzed Caffeine level per pill, per serving and per day



Theobromine and Theophylline Results

Figure 4. Theobromine levels for 38 Products

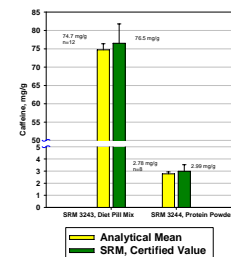


Thirty-eight of the 63 products contained theobromine in all lots (n=2 or 3) analyzed. Ten products had a mean value <0.2 mg/pill; 15 products contained between 0.2 and 1 mg/pill; 8 products contained between 1 and 5 mg/pill and 5 products contained between 5 and 15 mg/pill.

For theophylline, only 9 products had measurable levels (mean = 0.22 mg/pill) in all lots (n=2 or 3) analyzed.

Quality Control Results

Figure 5. Standard Reference Material (SRM) Results for Caffeine



Two SRMs were analyzed with each HPLC analysis of supplement products. In Figure 5, the results show that analytical values for both the lower level caffeine SRM and higher level caffeine SRM were well within the certified ranges. Blinded duplicates were analyzed as part of the quality control measure. The %CV for the duplicate data for caffeine was 3.1%, with a per product range of 0.0031 to 9.6%. Duplicate theobromine analyses showed a 2.6% CV with a per product range of 0.11 to 15.0%. Theophylline duplicates showed a %CV of 8.14% with a per product range of 1.11 to 27%.

Conclusions

- The quality control results for this study indicate that consistent and accurate results can be obtained for caffeine and theobromine analysis in an herbal matrix using HPLC and SRMs.
- For most of the weight-loss and sports performance-enhancing products analyzed in this study, the caffeine level measured was within 20% of any quantifiable level on the label.
- On average, the products with label claims for caffeine contained more than twice the levels of caffeine as the products that did not have a label claim for caffeine content.
- If a consumer took the maximum recommended number of pills for these products:
 - Approximately 1/3 of the products analyzed contained caffeine amounts of less than 120 mg per day.
 - Approximately 1/3 of the products had caffeine levels between 140 and 260 mg/day.
 - Approximately 1/3 of products had caffeine levels ranging from 300 to 830 mg per day. Four of these products had caffeine amounts greater than 600 mg per day. A daily intake of 830 mg would provide as much caffeine as nearly nine 8-ounce cups of brewed coffee¹.

¹Nutrient Data Laboratory home page, <http://www.ars.usda.gov/ba/bhnr/cdl/>

²Nutrition Business Journal <http://www.nutritionbusiness.com> (accessed January 29 2004).