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ORIGINAL PAPER

The caffeine contents of dietary supplements commonly purchased in the US: analysis of 53 products with caffeine-containing ingredients

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Abstract As part of a study initiating the development of an analytically validated Dietary Supplement Ingredient Database (DSID) in the United States (US), a selection of dietary supplement products were analyzed for their caffeine content. Products sold as tablets, caplets, or capsules and listing at least one caffeine-containing ingredient (including botanicals such as guarana, yerba mate, kola nut, and green tea extract) on the label were selected for analysis based on market share information. Two or three lots of each product were purchased and analyzed using high-pressure liquid chromatography (HPLC). Each analytical run included one or two National Institute of Standards and Technology (NIST) Standard Reference Materials (SRMs) and two products in duplicate. Caffeine intake per serving and per day was calculated using the maximum recommendations on each product label. Laboratory analysis for 53 products showed product means ranging from 1 to 829 mg caffeine/day. For products with a label amount for comparison (n=28), 89% (n=25) of the products had analytically based caffeine levels/day of between −16% and +16% of the claimed levels. Lot-to-lot variability (n=2 or 3) for caffeine in most products (72%) was less than 10%.

Keywords Caffeine · HPLC · UV/VIS · Dietary supplement · Reference material

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Introduction

Caffeine (1,3,7-trimethylxanthine) is an alkaloid that occurs naturally in the leaves, seeds and fruit of tea, coffee, cacao, kola trees and more than 60 other plants [1]. When ingested, it is a central nervous system stimulant and can temporarily increase blood pressure and heart rate [2, 3]. Some consumers may choose to limit their caffeine consumption because of these effects or for other reasons. While many people may know that foods and beverages such as coffee, tea, cola, and chocolate contain caffeine, they may not be aware that some dietary supplement ingredients contain caffeine (e.g., botanicals such as guarana, yerba mate, kola nut, and green tea extract [4]).

The United States Department of Agriculture (USDA) publishes food composition data that include levels of caffeine in foods [5]. The National Center for Health Statistics (NCHS)/National Health and Nutrition Examination Survey (NHANES) and USDA provide national food consumption data that allow the estimation of caffeine intake from foods [6, 7]. However, composition and consumption data are lacking for caffeine in dietary supplements.

In the US, all ingredients must be listed on food, beverage and dietary supplement labels, but there is no requirement to label the amount of caffeine in these products. For dietary supplements containing proprietary blends, however, the individual ingredients in the blends may not be listed in the product ingredient list. Although some dietary supplement labels voluntarily specify caffeine content and some also add voluntary warnings about limiting other caffeine intake, many do not. Many countries have begun to require caffeine labeling of specific beverages. In 2004, all 25 countries in the European Union (EU) began requiring that packaged drinks with more than 150 mg/L caffeine be labeled "high caffeine content," followed by the caffeine content expressed in mg/100 mL [8]. Most drinks marketed as energy drinks fit into this category, but most soft drinks do not. Drinks based on tea and coffee are exempt from this EU ruling as long as the name of the drink makes it clear that it has been made from tea or coffee. Food Standards Australia and New Zealand (FSANZ) recently adopted mandatory advisory statements on food labels requiring a statement on the label if a product contains added caffeine, guarana or guarana extract [9].

In order to gather some preliminary information on the caffeine levels in dietary supplements in the US, the Nutrient Data Laboratory (NDL) analyzed a representative sampling of caffeine-containing dietary supplements purchased in 2004 and 2005. For this project, NDL was funded by and collaborated with the Food and Drug Administration (FDA) and the National Institutes of Health (NIH) Office of Dietary Supplements (ODS). This project is part of a larger study initiating the development of an analytically validated Dietary Supplement Ingredient Database (DSID) in the US.

Reliable analytical methods and the use of appropriate reference materials are essential for producing high-quality analytical data. Researchers analyzing dietary supplements for their caffeine content now have access to two standard reference materials (SRMs) from the National Institute of Standards and Technology (NIST) [10], SRM 3243 and 3244, with representative levels of caffeine and appropriate matrices, that can be used to validate their analytical methods. Organizations that rely on contract laboratories for analysis also have these control materials available for quality assessments. High-performance liquid chromatography (HPLC) methods are commonly used for the analysis of caffeine in food [11], beverages [12–14], and botanical matrices [15, 16]. For this study, a published method for the analysis of caffeine in beverages [17] was modified by adding a gradient to the mobile phase and a clean-up step to eliminate interferences.

Sampling plan

In order to identify caffeine-containing ingredients on product labels and product websites, a literature search was conducted, and the National Health and Nutrition Evaluation Survey (NHANES 2001-02) dietary supplement data files [18] were reviewed. Table 1 lists the terms identified from these searches, which are commonly used on labels for caffeine-containing ingredients in dietary supplement products [19, 20].

Sports nutrition and weight loss products represent the segment of the US dietary supplement market that has products that may contain caffeine, although some multivitamin and mineral products also contain caffeine. The sample of products to be analyzed in this study was drawn according to retail channel, stratified by 2001 market data from the Nutrition Business Journal [21], identifying major supplement manufacturers. Products sold as tablets, caplets, or capsules and listing at least one caffeine-containing ingredient on the label were selected based upon the market share in four categories corresponding to retail channels: (1) health food/natural food outlets (30.1%); (2) supermarkets, drug stores, mass merchandisers (25.4%); (3) multilevel marketers, internet, and catalog vendors (41.3%); and (4) practitioners, including fitness clubs (3.2%).

Eighteen products were chosen from three leading health food/natural food stores. The top sellers were selected with certainty (i.e., with 100% probability) based on internet sales information, and the remaining products were randomly selected from all caffeine-containing products found on the shelves in the three retail stores.

Based upon market information from ACNielsen (Schaumburg, IL, USA), product classes of dietary supplements sold in supermarkets, drug stores, and mass merchandisers were reviewed. Dietary supplement products from each product class were selected randomly. Supple-

Table 1 Common caffeine-containing ingredients and label terms

Common name, ingredient	Label terms identified
Coffee	Coffee, coffea, caffeine
Cocoa, cacao	Cocoa, *Theobroma cacao*, chocolate
Guarana	Guarana, *Paullina cupana*, Brazilian cocoa
Kola nut	Kola nut, cola seeds, *Cola nitida*
Green tea, black tea	Green tea, black tea, *Camellia sinensis*, *Theo sinensis*, *Camellia* sp.
Yerba mate	Yerba mate, mate, *Ilex paraguariensis*

ments that listed a caffeine-containing ingredient were identified via the internet and ten products were selected. To take a closer look at mass merchandisers not represented by ACNielsen market data, two major retailers were visited in order to determine which caffeine-containing supplements were sold in those stores. Five additional products for the sample were randomly selected from all available caffeine-containing supplements sold in the two stores.

For the third category, a list of direct marketers from the Nutrition Business Journal (stratified by sales) and a list of publicly held multilevel marketers (from http://www.mlmwatch.org) were combined. Twenty-one caffeine-containing dietary supplements were identified and selected from these companies. To provide the remaining four products in the category, the internet was searched for caffeine-containing dietary supplements. The first three sites drawn from Google, Lycos, and Yahoo were reviewed, and three products were randomly selected from each of the three search engines. The nine products selected included five alternate products.

The remaining two products represented caffeine-containing dietary supplements sold by health practitioners and health clubs. A health practitioner in a list of direct marketers from the Nutrition Business Journal was randomly chosen, and a dietary supplement containing a caffeine ingredient was identified for the sample. In addition, health clubs that sold dietary supplements were researched, and one caffeine-containing dietary supplement was identified from a health club that sells its own products.

Product purchase and preparation of samples sent to the laboratory

The sources used to purchase caffeine supplements were local stores, internet merchandisers, and catalogs. Products were purchased by NDL staff every few months over a period of nine months from July 2004 to April 2005. Most supplements were bought via the internet. Every effort was made to procure a different lot code with each purchase in order to obtain three different lots for each product. Approximately half of the products purchased contained information about caffeine levels on the label.

For each dietary supplement purchase, a minimum of 90 tablets, caplets, or capsules from the same lot were required. At NDL, 30 tablets, caplets, or capsules from each supplement product were counted into amber plastic jars which were labeled with a batch number and a unique sample-testing number. For the remainder of this report, the terms tablet and tablets will be used to denote a unit or units that may be tablets, caplets, or capsules.

Three sample shipments were sent to an independent laboratory experienced in the analysis of caffeine and the analysis of dietary supplements. Within each shipment, each product was categorized into one of three batches for analysis, according to the caffeine level stated on the product label or to an estimated caffeine level. The three batches were defined as <50 mg caffeine/tablet, 50–100 mg caffeine/tablet and >100 mg caffeine/tablet, based on the distribution of caffeine seen in the purchased products with caffeine levels on the label. If the level of caffeine was not included on the label, caffeine levels were estimated based on the number and order of caffeine-containing ingredients on the label and other label information (e.g., warnings to limit caffeine from other sources). Adjustments were made to the batch assignments for shipments 2 and 3 based on the results from shipment 1. Two sample matrices for products were defined for the laboratory: botanical blend and multivitamin/botanical blend.

Each batch of samples included one or two NIST SRMs and two products in duplicate. Approximately 75 samples were sent for caffeine analysis for each of the 3 shipments. The NIST SRMs analyzed with supplement products were NIST SRM 3244 Ephedra-Containing Protein Powder

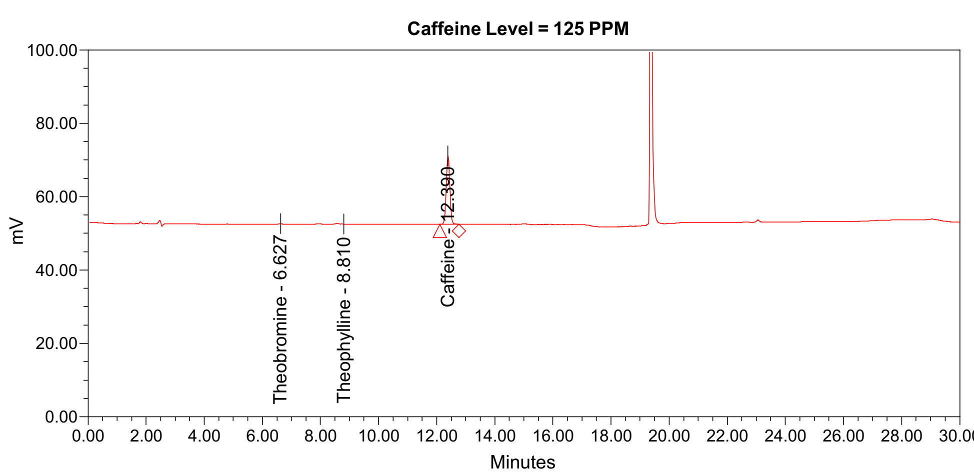

Fig. 1 Sample chromatogram for a product with a low level of caffeine (0.125 mg/g, retention time: 12.4 min). Chromatographic conditions are described under "Laboratory materials and methods"

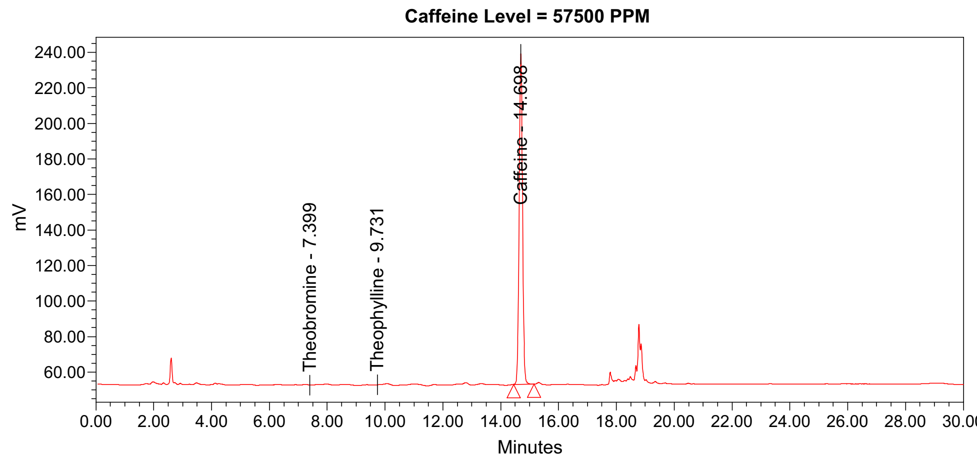

Fig. 2 Sample chromatogram for a product with a higher level of caffeine (57.5 mg/g, retention time: 14.7 min). Chromatographic conditions are described under "Laboratory materials and methods"

(certified caffeine level: 2.99±0.41 mg/g) and NIST SRM 3243 Ephedra-Containing Solid Oral Dosage Form (certified caffeine level: 76.5±4.1 mg/g).

Laboratory sample preparation and analysis

Tablet weighing and preparation

At the laboratory, 20 tablets from each sample were homogenized for subsampling in order to minimize errors that may occur due to variability in ingredient composition for individual tablets. (This is the recommended practice by United States Pharmacopeia for such products [22]). Twenty tablets of each supplement product were weighed together and the total mass divided by 20 to determine the average mass of one tablet. If the product was encased in a capsule, the capsule mass for the 20 capsules was subtracted from the total mass to determine the average mass of the contents of one capsule.

The following procedures were used for the preparation or grinding of tablets, caplets, pull apart powder-filled capsules, hard gelatin capsules, and soft gelatin capsules:

1. For tablets and caplets (coated tablets), 20 tablets were weighed and then homogenized in an orbital ball mill grinder. The homogenate was stored at room temperature.
2. For powder-filled capsules that were easily pulled apart, 20 capsules were weighed. Each capsule was then pulled apart, emptied and cleaned with a cotton swab to remove excess powder. The 20 empty capsules were weighed. The powder was mixed and stored at room temperature.
3. For hard gelatin and soft gelatin capsules, 20 capsules were weighed. Each was then cut open with a razor blade and the contents were removed. Each capsule was rinsed with hexane at least three times and dried under nitrogen. The 20 capsules were weighed. Capsule contents (usually liquid) were refrigerated.

Laboratory materials and methods

Reagents used were purified water, HPLC-grade acetonitrile (ACN), and reagent-grade acetic acid. The caffeine standard (99.6% purity) was purchased from Sigma (St. Louis, MO, USA). A stock solution of caffeine (250 µg/ml) was prepared and stored at 5 °C. Working level standards were prepared by diluting the stock solution in mobile phase at the following ratios: 200 µL to 100 mL, 400 µL to 100 mL, 2 mL to 100 mL, 4 mL to 100 mL, 8 mL to 100 mL. The least concentrated standard was designed to achieve a limit of detection of 0.005% based on a 1 g sample diluted to 100 mL (LOD=0.05 mg/g).

One gram of each sample was mixed with 15 mL of water, heated to boiling for 3–5 min, and after cooling, brought to volume in a 100-mL flask. The solution was filtered through 2 V filter paper. The sample extract was filtered through 0.45-µm filter into an autosampler vial for analysis. The chromatographic analysis was performed on a high-performance liquid chromatograph (HPLC) system with detection by UV absorbance at 272 nm. A 150 mm × 4.6 mm i.d. ODS-3 column (Phenomenex Prodigy ODS-3 100A, 5-µm particle size; Torrance, CA, USA) was used for the separation.

HPLC conditions: flow rate, 1 mL/minute; mobile phase A, 0.1% H_3PO_4 in water; mobile phase B, 100% ACN.

Table 2 Distribution of analytical caffeine levels, in mg/day, in 53 dietary supplement products and comparison to caffeine in coffee

Number of products (*n*=53)	mg caffeine/day	Comparable approximate number of cups of coffee/day
27	0 to <200	1 to <2
11	200 to <400	2 to <4
11	400 to <600	4 to <6
3	600 to <800	6 to <8
1	>800	>8

Gradient:

Time (min)	%A	%B
0	95	5
3	92	8
14	85	15
18	40	60
24	40	60
26	85	15
28	95	5
30	95	5

The chromatographic system was calibrated with at least a five-point standard curve for each set of samples analyzed. Standards were run after every fourth sample. Excellent reproducibility was seen in the standards; typically the *R*-value for the calibration curve was 0.9999 or better. The method was validated with a % relative standard deviation (RSD=standard deviation/mean ×100) of 4.86% and spike recoveries ranging from approximately 93 to 103%. The limit of quantitation was 0.1 mg/g.

Results and discussion

Quality control evaluation

One or both of the control materials, SRM 3243 and SRM 3244, were analyzed with each HPLC analysis of supplement products. Before reviewing product data, caffeine results

Table 3 Analytical mean caffeine values for dietary supplements listing caffeine-containing ingredients: products with no specific label information about caffeine content

Product	Caffeine ingredients[a]	Number of vitamins and minerals	Supplement form	Mean analyzed caffeine (mg/day)	SD. (mg/day)	RSD (%)	Number of lots analyzed
1	green tea, caffeine, guarana	3	Capsule	622.22	24.71	3.97	3
2	guarana, black tea, green tea	1	Tablet	530.89	33.79	6.36	3
3	green tea, cocoa, yerba mate	4	Capsule	440.45	30.26	6.87	2
4	green tea, cocoa, yerba mate	4	Capsule	411.83	6.55	1.59	3
5	yerba mate, green tea, cocoa	4	Capsule	396.14	36.44	9.20	3
6	green tea, yerba mate, guarana, cacao	2	Tablet	237.89	15.80	6.64	3
7	green tea, guarana, kola nut	2	Capsule	217.01	4.67	2.15	2
8	kola nut	0	Capsule	190.89	11.74	6.15	2
9	guarana, kola nut, yerba mate	1	Tablet	142.81	35.74	25.03	3
10	kola nut	0	Capsule	72.68	2.54	3.50	3
11	green tea, kola nut	0	Capsule	61.87	23.33	37.71	3
12	kola nut	0	Capsule	61.45	4.42	7.20	3
13	guarana	0	Capsule	41.72	0.74	1.76	3
14	guarana, kola nut	31	Tablet	33.08	1.92	5.81	3
15	green tea	0	Capsule	20.01	0.32	1.59	2
16	green tea	20	Tablet	17.88	3.03	16.93	3
17	green tea	0	Liquid Gel Caps	15.35	6.00	39.13	3
18	green tea	0	Capsule	13.67	1.87	13.84	2
19	green tea	0	Capsule	12.66	2.66	20.97	2
20	green tea	0	Capsule	9.36	7.02	75.00	3
21	green tea	0	Capsule	2.39	0.38	16.00	3
22	green tea	3	Capsule	1.05	0.16	14.86	3
23	cocoa	1	Tablet	0.81	0.40	48.83	2
24	green tea	2	Capsule	0.72	0.06	8.74	3
25	green tea	23	Tablet	0.60	0.15	24.57	3

[a] Caffeine-containing ingredients are listed in the order in which they were listed on the label. Ingredient names were adjusted to the common names listed in Table 1.

for the SRMs and blinded duplicates were evaluated. For both SRMs, analytical results were within the certified ranges for all analytical runs. For SRM 3244, the mean (n=8) was 2.78 ± 0.16 mg/g. The certified value is 2.99 ± 0.41 mg/g. For SRM 3243, the mean (n=12) was 74.69 ± 1.70 mg/g. The certified value is 76.5 ± 4.1 mg/g.

Caffeine results for products that were analyzed in duplicate in the same batch of samples were compared to each other. The mean RSD for the duplicate data was 3.0%, with a per product range of 0 to 11.2%.

Chromatograms from two typical products (one with a lower caffeine level and one with a higher caffeine level) are shown in Figs. 1 and 2.

Product caffeine level calculations and evaluation

As indicated, attempts were made to purchase three different lots of the 60 products. Because some products were discontinued or unavailable in multiple lots during this time period, replicated lots (n>1) could not be obtained

Table 4 Analytical mean caffeine values for dietary supplements listing caffeine-containing ingredients: products with specific label information about caffeine content

Product	Caffeine ingredients[a]	Number of vitamins and minerals	Label information: caffeine (mg/day)	Mean analyzed caffeine (mg/day)	SD (mg/day)	RSD (%)	Number of lots analyzed
26	guarana, kola nut, yerba mate, green tea	9	750	828.71	37.58	4.53	3
27	yerba mate, caffeine, guarana, green tea, kola nut, cocoa	1	600	745.51	40.52	5.44	3
28	kola nut, yerba mate, green tea, caffeine	0	600	613.25	4.09	0.67	3
29	caffeine	1	600	554.39	46.69	8.42	3
30	guarana, green tea, caffeine, yerba mate, kola nut, cacao	0	552	554.28	8.53	1.54	2
31	green tea, guarana	8	528	549.68	21.30	3.88	3
32	guarana, green tea	0	528	528.61	24.72	4.68	3
33	guarana, caffeine, black tea, green tea	0	525	560.75	11.03	1.97	3
34	green tea, yerba mate, guarana, cocoa, kola nut	1	492	483.90	20.03	4.14	3
35	yerba mate, guarana, green tea, cocoa, kola	0	480	413.25	128.67	31.14	2
36	green tea, yerba mate	1	402	439.17	39.20	8.93	3
37	cacao, yerba mate, green tea	2	336	330.01	7.99	2.42	3
38	green tea, guarana, yerba mate	5	330	351.56	18.88	5.37	3
39	guarana, green tea, yerba mate, caffeine	1	324	333.11	3.99	1.20	3
40	green tea, caffeine, kola nut, guarana, yerba mate	3	320	140.54	22.84	16.25	2
41	cocoa, green tea	8	300	148.56	3.85	2.59	2
42	black tea, guarana, yerba mate, cacao	2	272	227.53	33.87	14.89	3
43	green tea, guarana	1	244	262.82	7.15	2.72	3
44	cocoa, green tea, guarana	0	234	252.31	6.96	2.76	3
45	caffeine	4	225	226.13	7.34	3.25	2
46	guarana, green tea, caffeine	0	200	218.44	2.90	1.33	3
47	guarana, green tea	1	200	196.65	0.97	0.50	3
48	guarana, black tea	2	180	187.62	3.30	1.76	3
49	green tea	2	150	172.00	8.43	4.90	3
50	green tea, caffeine	1	150	134.53	6.50	4.83	3
51	green tea	0	100	173.12	25.16	14.53	3
52	green tea	1	100	116.21	10.65	9.17	3
53	guarana	0	90	95.31	7.13	7.49	2

[a] Caffeine-containing ingredients are listed in the order in which they were listed on the label. Ingredient names were adjusted to the common names listed in Table 1.

for all products. The data in this report represent data for these replicated lots for products listing at least one caffeine-containing ingredient (n=53).

The channel distribution for the final product statistics was similar to that which was planned. Health food/natural foods outlets were represented by 32% of products (n=17); supermarkets, drug stores and mass merchandisers by 21% of products (n=11); multilevel marketers, internet, and catalog vendors by 43% of products (n=23); and practitioners by 4% of products (n=2).

Results obtained in mg/g were converted to mg/tablet using the average mass of 20 tablets or the average mass of the contents of 20 capsules. Label instructions for different products directed consumers to take various numbers of tablets per serving and per day (ranging from 1–4 tablets per serving and 1–4 times per day). Caffeine intake per serving and per day was calculated for each product using the maximum recommendations on the product label.

Laboratory analysis for all 53 products showed product means ranging from 0.07 to 307 mg caffeine/tablet and 1 to 829 mg caffeine/day. For 13 of the products there were n=2 lots, and for 40 products there were n=3 lots. Results have been summarized in mg caffeine/day, because label instructions varied so widely among the products (from 1 tablet/day to 4 tablets/serving and 3 servings/day). Among the 53 products, the RSD ranged from 0.5% to 75% for the individual products (n=2 or 3 lots). The lot-to-lot variability for most products was reasonable, with about 72% of the products (n=38) having RSDs of less than 10%. Another 17% of the products (n=9) showed RSDs ranging from 10% to less than 25%. Of the remaining 11% of the products (n=6) with RSDs ranging from 25% to 75%, five of these products contained levels below 50 mg caffeine/day.

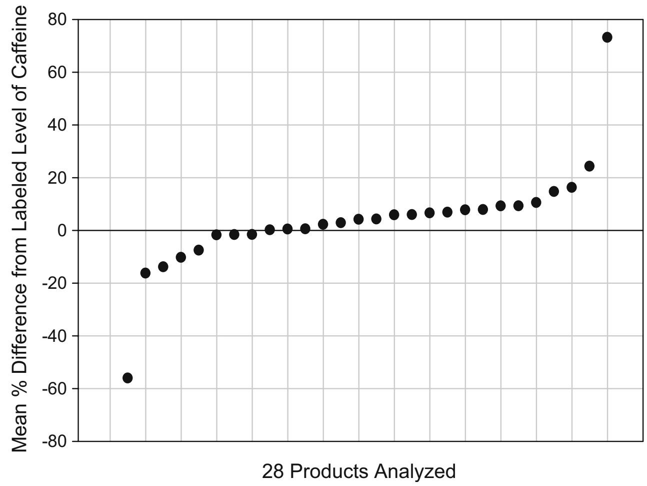

Fig. 3 Dietary supplement products labeled with a specific caffeine label: mean percentage difference from label

According to the USDA food composition database [23], one cup (8 oz, 240 ml) of brewed coffee contains approximately 95 mg of caffeine. Using this value as a reference, the 53 products analyzed provide a level of caffeine that ranges from zero to more than eight cups of coffee/day (see Table 2).

Product grouping and analysis

For the analysis of results in this study, products have been divided into two groups based on whether product labels listed a specific amount of caffeine or not. Tables 3 and 4 list results by product number, caffeine-containing ingredients, number of vitamins and minerals, supplement form, mean analytical caffeine level, standard deviation (sd), RSD, and number of lots analyzed. Table 4 contains the products (26–53) with a labeled caffeine level for comparison. In this table, the level on the label was adjusted to mg/

Table 5 Label information factors found to be indicators of significantly higher caffeine levels in tested products

Label factor[a]	Factor not present on label	Factor present on label	p value
	Mean analyzed caffeine level, mg/day[b]		
Caffeine listed as an ingredient on label	164 (121, 222)[c]	390 (234, 649)	0.0034
Yerba mate listed as an ingredient on label	131 (92, 186)	489 (310, 770)	0.0001
Label message to limit other caffeine	147 (96, 226)	434 (291, 646)	0.0002
Guarana listed as an ingredient and caffeine absent from label	95 (60, 149)	284 (190, 424)	0.0004

[a] *Label factor* refers to specific information either present or absent on product labels in this study.
[b] Mean calculated as the geometric mean (the inverse transformed log mean) of analyzed caffeine values (calculated as mg/day).
[c] Lower and upper 95% confidence limits.

day (mg per tablet or per serving times maximum servings/day recommendation).

For the products without specific caffeine levels listed on the label, the mean analyzed level of caffeine in mg/day was 142 (range: 1–622). For the products with specific caffeine levels listed on the label, the mean analyzed level of caffeine in mg/day was 351 (range: 95–829).

Additional statistical evaluation of these results using geometric means (to account for the skew of the data to the right) indicated that the mg caffeine/day in products with a labeled amount of caffeine (geometric mean=238, 95% confidence limits of 175–330) was significantly different ($p<0.0001$) from those with no label amount (geometric mean=73, 95% confidence limits of 50–107).

For products with the level of caffeine provided on the label for comparison ($n=28$), the percent difference from the label amount was calculated [(mean analyzed value − label value/label value)×100]. These calculations indicated that 89% ($n=25$) of the products had analytically based caffeine levels that fell between −16% and +16% of the level of caffeine provided on the label. For the remaining three products, the percent difference between the analyzed and label levels for caffeine was −56%, +24% and +73%. All results are shown in Fig. 3.

Label information regarding caffeine-containing ingredients and any warnings about limiting caffeine intake from other sources were recorded for each product and evaluated statistically. Table 5 shows the results of this analysis. Mean analytical caffeine levels were calculated for product groupings based upon the presence or absence of specific label information (factors). When products had labels listing caffeine or yerba mate as ingredients or a recommendation to limit other caffeine intake, these products were statistically higher in caffeine than products without those factors on the label, with a 95% confidence level ($p<0.004$). When products had labels listing guarana as an ingredient but not caffeine, analyzed caffeine levels were significantly higher than products that did not list either ingredient ($p<0.0005$). Significant differences ($p<0.05$) were not seen between analytical caffeine levels and the presence or absence of the following ingredients on the label: kola nut, tea, cocoa, and their synonyms.

Conclusions

Caffeine levels in botanical and multivitamin matrices can be consistently and accurately assessed using HPLC analysis and SRMs for quality control.

In the US, dietary supplement products may contain caffeine in proprietary blends or from botanical sources (e.g., guarana, yerba mate, cocoa, kola nut and green tea extract), even if caffeine is not listed as an ingredient on the label. Less than one-third (11 of 36) of the products whose analyzed caffeine content was more than one cup of brewed coffee/day listed caffeine as an ingredient, although many of these products (27 of 36) voluntarily listed a caffeine level on the label.

Caffeine intakes from the dietary supplement products analyzed in this study ranged from 1 mg to greater than 800 mg/day, if taken at maximum recommended dosages. For most (89%) of the caffeine-containing dietary supplements that listed a level of caffeine on the label, the mean analyzed level calculated on a per day basis was similar to the labeled amount (within 20%). Most products (72%) showed a lot-to-lot variability of less than 10%.

This study is a first step in evaluating caffeine-containing dietary supplements. The products analyzed in this study were complex mixtures of botanicals or botanicals with one or more vitamins and minerals. Although some significant differences were seen for the products analyzed in this study, any related conclusions would require additional research, including the analysis of additional products, the monitoring of products over time and the evaluation of appropriate product groupings.

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