Green Tea Product Epigallocatechin Gallate (EGCG) Content and Label Information: A Descriptive Analysis

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Abstract: Green tea's popularity can be largely attributed to its potential health benefits, with an emphasis on antioxidant properties from its catechin constituents, especially (−)-epigallocatechin-3-gallate (EGCG). EGCG appears to be responsible for many of the potential health benefits of green tea. However, while higher intake levels may provide benefit, lower intake levels may not. The objective was to determine whether commercially available green tea products provide label information about EGCG content and other constituents and then to analyze the label information in terms of existing research. A descriptive analysis of product label information was conducted. In total, 105 green tea products evaluated, 58% of green tea supplements and 5% of green tea beverages included information about EGCG content on the label. Among the dietary supplement products providing sufficient information on the label, the amount of EGCG listed ranged from 70 mg to 600 mg per serving. The average EGCG per serving was 223.7 mg. The average reported caffeine content was 56.0 mg per serving. In conclusion, most green tea beverages to not provide adequate information about EGCG or other constituents. Green tea supplements are more likely to provide this information. One to two servings of green tea supplements are typically needed to achieve EGCG or catechin intake levels similar to those demonstrating efficacy in clinical studies. Consumers should consider selecting products that adequately describe constituent information on the label. Manufacturers should consider providing this essential information on the product label in order to better inform consumer decision-making.

Keywords: Nutraceutical, green tea, catechins, EGCG, supplement labeling.

INTRODUCTION

Tea is obtained from the leaves and buds of the *Camellia sinensis* plant. There are several different forms of tea including green, black, pu-erh, and oolong or white tea [1,2]. How the *Camellia sinensis* plant parts are grown, harvested, and processed will determine the form obtained.

There has been particular interest in green tea due to health benefits associated with its consumption. In large part, these benefits have been attributed to green tea's high concentration of catechins, specifically the major catechin, (−)-epigallocatechin-3-gallate (EGCG) [3,4]. Notably, EGCG makes up about 60% of the total catechins in green tea [5].

The Tea Association of the U.S.A. Inc. reports that in 2014, Americans consumed over 80 billion servings of tea, total imported tea was worth 10.8 billion dollars, and green tea sales have grown 60% in volume over the past 10 years [6].

Clinical studies have been conducted evaluating the effects of EGCG and green tea catechins in conditions such as cancer, hyperlipidemia, diabetes, and many more [5,7-10]. No consensus on an optimal EGCG dose or intake level currently exists; however, evidence suggests that higher green tea catechin levels and specifically EGCG are needed for therapeutic effects. A meta-analysis of 20 randomized controlled trials evaluating the effect green tea catechins on lipid levels reported that green tea intake ranged from 145-3000 mg/day. EGCG doses ranged from 68-1037.8 mg/day. Subgroup analysis found that 200 mg of EGCG or more was necessary to decrease total cholesterol and low-density lipoprotein (LDL) cholesterol levels. Lower intake levels had no effect [8]. In another pooled analysis, a higher green tea catechin intake (≥457 mg/day) resulted in significant decreases in fasting blood glucose in diabetic subjects, while a lower intake had no effect [9]. In a randomized controlled study, 750-1000 mg/m^2 of green tea extract (corresponding to a higher plasma level of EGCG) increased clinical response in patients with high-risk oral premalignant lesions. Again, lower intake levels of green tea extract, 0-500 mg/m^2 (and subsequent lower blood levels of free EGCG) had no effect [10]. These data suggest that higher intake levels of green tea catechins, specifically EGCG, are more likely to result in therapeutic effects.

In addition to health benefits, some potential harms may be associated with EGCG intake levels. Preliminary research in animals showed that oral doses ranging from 500-1500 mg/kg of EGCG caused

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increases in biochemical markers for liver injury as well as moderate to severe hepatotoxicity [11,12]. Based on allometric scaling, an equivalent human dose would be 30-90 mg/kg [11]. Several cases of green tea-related hepatotoxicity have also been reported. However, causality is difficult to assess in many of these reports [13]. Clinical research in humans has found that EGCG at doses of 800 mg and 1600 mg do not adversely affect the liver [14,15].

Given the important role of EGCG in the potential health benefits and harms of green tea, it is important for green tea consumers and healthcare practitioners to be able to recognize the amount of EGCG in commercially available green tea products.

This analysis was undertaken in order to evaluate and characterize the labelled amounts of EGCG and other contents of commercially available green tea products.

METHODS

In order to identify commercially available green tea products, a systematic search was conducted using Google and Bing search engines, as well as the Google and Bing shopping services from January 25th to January 29th, 2013. The search terms used were "green tea" in combination with one of the following: "capsule", "tablet", "pill", "extract", "drink", "beverage", "leaf", "powder", or "matcha powder". Commercially available single-ingredient green tea or green tea with caffeine products were included if they were ingestible dietary supplements or beverages. Decaffeinated and flavored products were also included. Products in which green tea did not appear to be the main ingredient were excluded.

For each product identified, label information was characterized including brand and manufacturer, green tea form (e.g., extract, powder, tablet, or capsule), strength or concentration, and the amounts of EGCG, catechins, caffeine, and polyphenols, if provided. In addition, dosing instructions and serving sizes were tabulated.

RESULTS

The systematic search identified 105 green tea products. Of these, 54 (51%) were brewable tea beverages, 45 (43%) were dietary supplements (tablets or capsules). The remaining six were non-brewable tea beverages.

Of the 60 tea beverages identified, only 3 (5%) reported EGCG content. In these products the average EGCG per serving was 94.3 mg (range: 83-100 mg).

Caffeine content was provided for 19 of 60 (32%) green tea beverages identified. Average caffeine content per serving was 29.6 mg (range: 4-72.5 mg).

For green tea-containing dietary supplement products, 37 out of 45 (82%) reported the amount of green tea extract. The average was 584.2 mg per serving (range: 100-1950 mg).

EGCG content was provided for 26 out of 45 (58%) dietary supplement products. The average EGCG per serving was 223.7 mg (range: 70-600 mg). Additionally, 17 out of 45 (38%) products reported catechin content. The average catechin content was 357.8 mg—per serving (range: 125-700 mg). Thirty out of 45 (67%) reported total polyphenol content with the average being 347.3 mg per serving (range: 95-800 mg).

Caffeine content was reported for 16 out of 45 (36%) green tea dietary supplement products. The average reported caffeine content was 56.0 mg per serving (range: 0-160 mg).

For green tea-containing dietary supplement products, labelled dosing recommendations ranged from 1 to 3 servings daily. Based on these recommendations, average daily EGCG intake would be 273 mg (range: 75-600 mg). Average daily caffeine intake would be 76.8 mg (range: 0-320 mg).

DISCUSSION

These data show that green tea beverages rarely describe the EGCG or caffeine content of the product on their labels. Green tea-containing dietary supplements are much more likely to provide this information on the product label compared to beverages, but still only 58% of these products reported EGCG content and only 36% reported caffeine content.

Green tea beverage products that were assessed contained less than half of the EGCG content per serving of green tea dietary supplements products.

Some previous clinical research found that EGCG intake of at least 200 mg or total catechin intake of at least 457 mg was necessary for therapeutic effects [8,9]. In most cases, two or more green tea beverage servings would be needed to achieve this EGCG intake

level. For green tea dietary supplements, a single serving would achieve adequate EGCG intake in most cases. However, more than one serving would usually be needed to achieve total catechin intake above 450 mg. Green tea dietary supplement labelling typically recommends 1-3 servings per day.

For dietary supplement products, label information regarding caffeine content suggests that most products are not likely to provide a dangerous amount of caffeine if the suggested dosing schedules are followed. Caffeine poisoning can occur at an intake of 10 mg/kg (about 750 mg) as a single dose, but the dose can vary based on the person's pre-existing tolerance or sensitivity to caffeine [16]. The FDA states that 400 mg caffeine per day is safe to consume for adults [18,19]. The range of caffeine intake based on average caffeine content and typically recommended serving amounts in the assessed green tea products is between zero and 320 mg daily. Consumers should take caution that the total amount of caffeine consumed throughout the day from different sources does not exceed 400 mg.

Our findings are similar to the findings of ConsumerLab.com, an organization that independently tests the content of dietary supplement products. ConsumerLab.com identified six green tea products which were tested and verified to contain an average of 188 mg EGCG per serving (range 75-326.25 mg) [17]. This EGCG content is lower than our finding of an average 223.7 mg EGCG content per serving (range: 70-600 mg).

LIMITATIONS

The findings of this study are limited in several ways. First, our search was limited to products advertised or available for purchase online. We identified 105 single-ingredient green tea products. The complete marketplace likely includes more than 105 products. However, we believe our sample is likely a fair representation of the broader market.

Additionally, we only evaluated the product content as stated on the label. The actual product content may vary substantially from what is reported on the label.

There is no current consensus about an adequate intake level of green tea catechins for therapeutic benefits. Therefore, accurate conclusions regarding whether commercially available green tea products provide an appropriate amount of green tea catechins, specifically EGCG, cannot be currently made.

CONCLUSION

Most great tea beverages and many green tea dietary supplements do not adequately report EGCG or caffeine content on the product label. EGCG is thought to be largely responsible for the health benefits from green tea. Patients who are interested in taking green tea for potential health benefits should seek out products that adequately report EGCG content on their label. Products that do not adequately report this information should be avoided.

Although manufacturers are not required to report levels of constituents in their product labeling, doing so would enhance consumers' ability to select an appropriate product to meet their health needs. Many standardized herbal extracts report constituent information on the product label. For example, standardized extracts of St. John's wort typically report the concentration of hypericin or hyperforin. Valerian extracts sometimes report valerenic acid concentration. Green tea product manufacturers should consider this approach to improve their labeling.

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