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The Comparison of Epigallocatechin Gallate Levels in Matcha Powders in Ceremonial, Premium and Culinary Grade by HPLC Method

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Abstract

This study compared EGCG content across ceremonial, premium, and culinary-grade matcha powders from Uji, Shizuoka, and Kagoshima using high-performance liquid chromatography (HPLC). A total of 27 samples were analyzed, and results showed that premium-grade matcha had the highest average EGCG concentration (19.28 mg/g), followed by culinary (13.60 mg/g) and ceremonial (8.19 mg/g). However, statistical analysis revealed no significant differences between the grades. Contrary to popular belief, ceremonial-grade matcha did not consistently contain the highest EGCG levels. These findings suggest that matcha grade and price are not reliable indicators of antioxidant potency. Premium-grade matcha may offer better value for those seeking health benefits associated with EGCG. Further studies are recommended to explore additional bioactive compounds and a larger sample size.

Keywords: Matcha, Ceremonial Grade, Premium Grade, Culinary Grade, EGCG, Catechin, Antioxidant, HPLC

Introduction

Matcha, a finely ground powder made from specially cultivated green tea leaves *(Camellia sinensis)*, has gained global popularity for its vibrant flavor, cultural significance, and numerous health benefits (Pastoriza et al., 2017; Wolf et al., 2008).

Rich in catechins—especially epigallocatechin gallate (EGCG)—matcha has been linked to anti-inflammatory, cardioprotective, and anticancer effects, contributing to its rise as a functional beverage in health-conscious communities (Farooq & Sehgal, 2018; Phuah et al., 2023).

As matcha consumption increases, the market offers a variety of grades, from ceremonial to culinary, with prices reflecting differences in production methods, leaf quality, and sensory characteristics (Meyer et al., 2023; Koláčková et al., 2019). Ceremonial-grade matcha is particularly prized for its vibrant color and umami-rich profile, while culinary-grade matcha is typically more robust and suited for blending. However, it remains unclear whether these higher prices are justified by the presence of significantly greater health-promoting compounds, such as EGCG.

This research investigates whether ceremonial-grade matcha contains higher concentrations of EGCG compared to premium and culinary grades. By clarifying the relationship between grade, price, and catechin content, the study aims to determine whether consumers derive greater health benefits from investing in higher-grade matcha.

Research Methodology

This study aimed to determine whether ceremonial-grade matcha contains a significantly higher concentration of epigallocatechin gallate (EGCG) compared to premium and culinary grades. A total of nine matcha powder samples from Japan were analyzed using High-Performance Liquid Chromatography (HPLC). The research followed ISO 14502-2:2005(E) standards.

Sample Collection

Matcha samples were sourced from five FDA-approved tea shops in Bangkok: Matcha Maru, Osha Ocha, Matchalabo, Matchaten, and Okucha Matcha. All products were imported from Uji, Shizuoka, and Kagoshima, three major matcha-producing regions in Japan (Ashardiono & Cassim, 2015; Sugawara, 2013; Pulkus & Moreno, 2024). Three grades—ceremonial, premium, and culinary—were selected per region, using the same cultivars to control for variation in leaf type and cultivation methods. All

samples were stored in light-protective containers, following ISO 1572 guidelines (International Organization for Standardization, 2005).

Table 1 Matcha Powder Samples

Brand	Product	Grade	Cultivar	Harvest	Price THB/g
Uji					
Matcha maru	Hikari (Single Origin)	Ceremonial	Hikari	1st	฿55
Matcha maru	Tenarai	Premium	Yabukita/ Samidori	1st & 2nd	฿14
Matchaten	Classic	Culinary	Yabukita/ Samidori	3rd	฿5
Shizuoka					
Osha Ocha	Yabukita (JAS Organic)	Ceremonial	Yabukita	1st	฿16
Osha Ocha	Yabukita	Premium	Yabukita	1 st	฿10
Matchalabo	Tsuko	Culinary	Yabukita/ Samidori	2nd	฿4
Kagoshima					
Matchamaru	Kagoshima 2.0 (Organic)	Ceremonial	Asanoka/ Sakimidori	1st	฿20
Matchamaru	Kagoshima 3.0 (Organic)	Premium	Asanoka/ Sakimidori	1st	฿14
Okucha Matcha	Shibushi	Culinary	Okumidori/ Yabukita	2nd	฿8

Table 1 presents detailed information on nine commercially available matcha powder samples sourced from three major tea-producing regions in Japan: Uji, Shizuoka, and Kagoshima. Each entry includes the brand and product name, grade classification (ceremonial, premium, or culinary), tea cultivar(s) used, harvest period, and price per gram in Thai Baht (THB/g).

Research Instruments

EGCG content was measured using High-Performance Liquid Chromatography (HPLC). The system specifications included:

Instrument: ACQUITY Arc System, WATERS (US)

Column: Cortecs C18 2.7 µm, 4.6 × 50 mm

Injection volume: 5 µLFlow rate: 2.0 mL/min

Column temperature: 30°C

Sample temperature: 10°CRun time: 12 minutes

Detector: UV at 210 nm

Mobile phase: 0.05% trifluoroacetic acid in water (A) and acetonitrile (B)

Data Collection

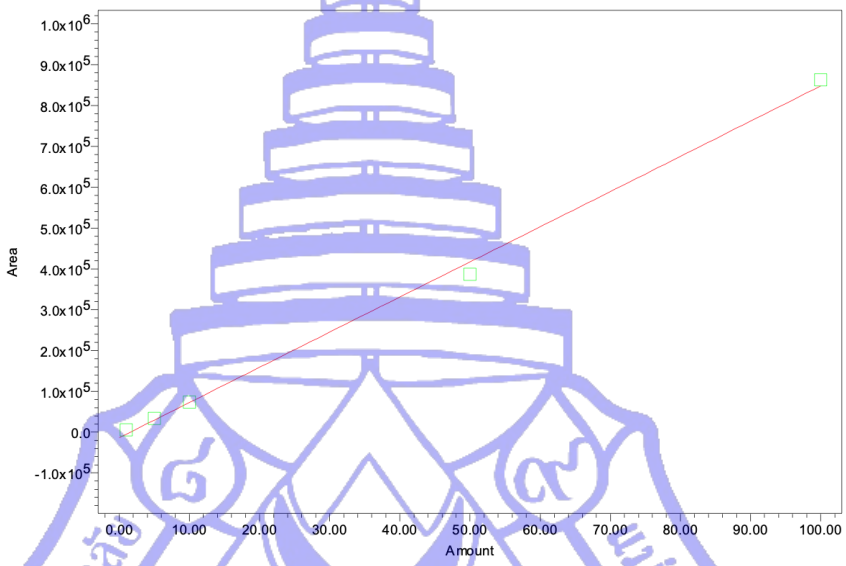
Each matcha sample was extracted in triplicate using the Mae Fah Luang Standard Operating Procedure. About 0.8 g of matcha was mixed with 50 mL of 80°C distilled water, stirred for 10 minutes, filtered, and re-extracted. The combined filtrate was adjusted to 100 mL. A standard stock solution of EGCG (1000 µg/mL in methanol) was diluted to prepare 1, 5, 10, 50, and 100 ppm calibration standards. HPLC analysis followed ISO 14502-2:2005(E). After system stabilization, standards and extracts were injected, and peaks were analyzed using data integration software. Equipment was flushed with 50% acetonitrile between runs (International Organization for Standardization, 2005).

Statistics Used for Data Analysis

All data were expressed as mean ± standard deviation and analyzed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp., 2015). To determine whether there were statistically significant differences in EGCG content among the three matcha grades, a one-way analysis of variance (ANOVA) was employed. To test the assumption of equal variances, Levene's test for homogeneity of variances was conducted. For post hoc comparisons, Tukey's Honestly Significant Difference (HSD) test was applied to identify specific differences between group means. A significance level of $p < 0.05$ was used for all statistical tests.

Results

High-Performance Liquid Chromatography (HPLC) was used to determine the concentration of epigallocatechin gallate (EGCG) in 27 matcha powder samples across three grades: ceremonial, premium, and culinary. A standard calibration curve (1–100 ppm) confirmed detection accuracy, with EGCG retention time consistently around 4.5 minutes, as shown in Figure 1.



Peak: EGCG

	Name	Level	X Value	Response	Calc. Value	% Deviation	Manual	Ignore
1	EGCG		1.000000	5469.291066	2.234586	123.459	No	No
2	EGCG		5.000000	33167.384806	5.448126	8.963	No	No
3	EGCG		10.000000	73393.957797	10.115224	1.152	No	No
4	EGCG		50.000000	386972.393842	46.496678	-7.007	No	No
5	EGCG		100.000000	862826.401017	101.705387	1.705	No	No

Figure 1 Calibration Plot

From Table 2, the results of the HPLC analysis of Premium-grade matcha showed the highest average EGCG content (19.47 ± 12.92 mg/g), followed by culinary-grade (13.51 ± 15.16 mg/g) and ceremonial-grade (8.19 ± 10.97 mg/g). Although individual premium samples—especially from Kagoshima and Shizuoka—had the highest values, overall variability within groups was considerable.

Table 2 Average EGCG Concentrations in Different Grade Matcha Powders

Matcha Grade	Average ECGC (mg/g)
Ceremonial	8.19 ± 10.97
Premium	19.47 ± 12.92
Culinary	13.51 ± 15.16

A one-way ANOVA revealed no statistically significant differences in EGCG content between the matcha grades. Levene's test confirmed the assumption of equal variances. Welch and Brown-Forsythe tests, along with Tukey's HSD post hoc analysis, also supported the absence of significant pairwise differences between groups.

In summary, while numerical differences in EGCG content were observed across matcha grades, statistical analysis confirmed these differences were not significant at the 95% confidence level.

Discussion

The results of this study contradict the initial hypothesis that ceremonial-grade matcha contains the highest levels of EGCG, a key antioxidant catechin. Instead, premium-grade matcha exhibited the highest mean EGCG content, while ceremonial-grade matcha had the lowest. This outcome aligns with studies by Meyer et al. (2023) and Horie et al. (2017), which suggest that sensory qualities such as flavor and color in ceremonial matcha stem from higher theanine and chlorophyll levels rather than catechins.

Moreover, Sano et al. (2018) noted that excessive shading—common in ceremonial-grade cultivation—can reduce EGCG biosynthesis, favoring amino acid enhancement instead. These findings imply that grade or price is not a reliable predictor of nutritional quality. Differences in cultivar, region, shading, and processing techniques may play a more substantial role. The variability in EGCG concentrations across regions, especially Kagoshima, further supports this complexity.

The findings are relevant to both consumers and industry stakeholders. Consumers should be aware that premium-grade matcha may offer better health value per cost, while producers may consider emphasizing measured bioactive content over

ceremonial labeling in marketing. Clear labeling and education on cultivation and processing practices could bridge the gap between consumer perception and actual product quality.

Conclusion

This study found no statistical support for the hypothesis that ceremonial-grade matcha contains the highest EGCG levels. In fact, it contained the lowest average EGCG concentration, challenging the assumption that higher-grade matcha provides superior health benefits. These findings reinforce the need for evidence-based labeling and suggest that premium-grade matcha may deliver a better balance between cost, nutrition, and antioxidant content.

Limitations

The main limitation of this study is the small sample size (n = 27), which may not capture the full variability across brands, batches, or regions. Additional influencing factors may include harvest timing, shading methods, particle size, and storage. The use of only one catechin (EGCG) as a nutritional indicator also narrows the scope of interpretation.

Future Research

Future studies should include a larger, more diverse sample set with multiple batches and brands across different harvests and regions. Analyzing a broader range of bioactive compounds (e.g., other catechins, L-theanine, caffeine) would give a more comprehensive profile of matcha's health value. Research should also examine the long-term stability of catechins under different storage and preparation conditions. Establishing standardized testing and labeling protocols would support both transparency and consumer trust in the growing matcha market.

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