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Short communication

Good cup quality roasted coffees show wide variation in chlorogenic acids content

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ABSTRACT

Chlorogenic acids (CGAs), of which the main representative is 5-caffeoylquinic acid (5-CQA), contribute to the quality and health benefits of coffee. However, excessive amounts of CGAs have been associated with a reduction in coffee cup quality. This paper describes the content of CGAs and 5-CQA in roasted coffees produced with different post-harvest processing (natural and pulped) methods and obtained from coffee quality contests in different Brazilian regions. These coffees differed in cup quality but the roasting degree was standardized. The amounts of CGA and 5-CQA were determined by HPLC. The CGA content ranged from 19.7 to 35.2 g/kg, and the 5-CQA content ranged from 8.0 to 16.4 g/kg. Overall, 5-CQA comprised 38–50% of the total CGA. No relationships between the chlorogenic acid levels and post-harvest process, location and/or cup quality were observed. Even when comparing roasted arabica coffees from different regions of Brazil and under different post-harvest processing, there was a wide variation in the total CGA (180%) and 5-CQA content (205%) for coffees with good cup quality with a similar roasting degree. Therefore, it is possible that coffees with good cup quality may also have a high CGA content.

1. Introduction

The primary coffee species that are commercialized throughout the world are *Coffea arabica* and *Coffea canephora*. The former has a higher cup quality and comprises more than 94% of Brazilian coffee exports (ICO, 2015).

Phenolic compounds comprise a large number of compounds that play a defensive role in the plant's adaptation and protection against environmental stress (Farah & Donangelo, 2006) and that stand out as the main source of dietary antioxidants (Gomez-Ruiz, Leake, & Ames, 2007; Torres & Farah, 2010). Chlorogenic acids (CGAs) are a major component in coffee, of which the main representative is 5-caffeoylquinic acid (5-CQA) (Farah & Donangelo, 2006).

Many beneficial health effects are attributed to the ingestion of GGAs, such as antimutagenic action, decrease in bloodstream glucose levels, cardiovascular benefits, and neuroprotective, anti-inflammatory and antioxidant activities (Tresserra-Rimbau, Medina-Remón, Estruch, & Lamuela-Rabentós, 2015; Han, Omri, Sasaki, & Isoda, 2015; Ludwig, Clifford, Lean, Ashihara, & Crozier, 2014; Frost-Meyer & Logomarsino, 2012; Johnston, Clifford, & Morgan, 2003; Lee & Zhu, 2006).

The presence of phenolic compounds directly affects the characteristics of a coffee brew, contributing to changes in color, flavor and aroma during the roasting process (Farah & Donangelo, 2006; Farah, Monteiro, Calado, Franca, & Trugo, 2006). However, a high CGA content has been associated with a reduction in coffee cup quality. Farah et al. (2006) observed that higher levels of caffeoylquinic acids (predominantly 5-CQA) and their oxidation products are associated with poor cup quality and with the Rio off-flavor.

Even in coffees of the same species, the composition depends on the genetics, on agronomic and edaphoclimatic conditions, and on post-harvest, roasting and storage processes (Kitzberger, Scholz & Benassi, 2014; Garrett et al., 2013; Leroy et al., 2006; Silva et al., 2005). Due to the genetic diversity, great variability of locations

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and growing conditions, and the use of various post-harvesting processes, Brazil, the world's leading producer of coffee, produces a wide range of coffee products.

In this paper, the chlorogenic acid content was determined of good cup quality roasted arabica coffees from different Brazilian regions that underwent different post-harvest processing (natural and pulped). The hypothesis of the research is that wide variations in CGA contents may occur even in good cup quality coffees.

2. Material and methods

2.1. Material

Good cup quality arabica coffee beans from coffee quality contests (State Contest Café Qualidade Paraná 2012 and National Contest Cup Excellence 2011) were provided by the Agronomic Institute of Paraná (Londrina, Brazil). These contests were prestigious competition and award for high quality coffees and the cupping evaluations were conducted by a qualified jury composed by industry experts. The green beans from different Brazilian regions were produced using different post-harvest processes (natural and pulped) and also presented diversity concerning cup quality (Table 1). Samples of south region were from Paraná State, samples of southwest region were from the States of São Paulo and Minas Gerais, representing the most important regions of arabica coffee production in Brazil.

Coffee beans were roasted in a pilot-type Rod-Bel roaster (São Paulo, Brazil) to achieve a weight loss of approximately 17%, which is considered a medium roasting degree. The samples were subsequently ground (Krups GVX208, Shanghai, China) to a granulometry of sieve size 0.84 mm. Roasted and ground coffees were placed in plastic bags and stored in a cold chamber at 5 °C until analysis.

The samples were characterized using an infrared moisture analyzer OHAUS-MB45 (Parsippany, USA) (105 °C for 5 min) and a KONICA Minolta-CR400 colorimeter (Osaka, Japan) with D65 illuminant. All measurements were performed in triplicate. The average moisture content was 27.0 ± 3.0 g/kg, and the results were used to express the contents in dry basis. The average brightness was 25.9 ± 2.5.

2.2. Analysis of chlorogenic acids

5-caffeoylquinic acid and acetic acid were purchased from Sigma-Aldrich (St. Louis, USA) and acetonitrile HPLC grade, from Fisher Scientific (Pittsburgh, USA). The analysis were carried out in a Shimadzu Liquid Chromatograph (Kyoto, Japan) with solvent pumping system (LC10 AD), Rheodyne injection valve (20 μL loop), CTO-20A column oven, and SPD-10A UV–Vis detector.

Samples (0.500 g) were extracted with 30 mL of water at 80 °C for 10 min. Extracts were filtered and properly diluted in the mobile phase. A gradient elution with water/acetic acid (95/5) (mL/mL) (A) and acetonitrile (B) was performed as follows: 0–5 min, 92:8 (A:B, mL/mL); 5–35 min, 85:15 (A:B, mL/mL), flow rate of 0.7 mL min^{-1}. A 4.6 × 250 mm 5 μm particle Spherisorb ODS1 column (Waters, Milford, USA) was used and detection was set at 320 nm.

Table 1
Content of total chlorogenic acids (CGA) and 5-caffeoylquinic acid (5-CQA) (dry weight) of roasted arabica coffees.

Sample	Brazilian region	Post-harvest process	Cup quality	CGA (g/kg)	5-CQA	
					g/kg	% CGA[c]
1	South	Natural	Very good [a]	19.7^{a} ± 0.3	8.0^{a} ± 0.1	40.7
2	South	Natural	Very good [a]	22.8^{ab} ± 1.6	9.3^{abc} ± 0.6	40.6
3	South	Natural	Very good [a]	24.0^{bcd} ± 0.2	1.0^{bcde} ± 0.1	41.7
4	South	Natural	Intermediate [a]	$27.1^{defghij}$ ± 0.8	11.2^{defg} ± 0.2	41.1
5	South	Natural	Intermediate [a]	24.8^{bcdef} ± 0.6	10.7^{cdef} ± 0.4	43.0
6	South	Natural	Intermediate [a]	28.8^{ghijkl} ± 0.8	12.7^{ghijkl} ± 0.1	44.0
7	South	Natural	Intermediate [a]	26.8^{defgh} ± 2.1	11.7^{fghi} ± 0.6	43.8
8	South	Natural	Intermediate [a]	31.8^{klm} ± 0.7	13.4^{ijklmn} ± 0.3	42.2
9	South	Pulped natural	Very good [a]	28.3^{fghijk} ±0.0	12.1^{fghij} ± 0.0	42.6
10	South	Pulped natural	Very good [a]	29.2^{fghijk} ± 0.3	12.6^{ghijk} ± 0.1	43.1
11	South	Pulped natural	Very good [a]	23.4^{bcd} ± 0.0	9.7^{abcde} ± 0.0	41.6
12	South	Pulped natural	Intermediate [a]	22.6^{abc} ± 0.9	9.5^{abcd} ± 0.2	42.1
13	South	Pulped natural	Intermediate [a]	26.9^{defghi} ± 1.3	11.8^{fghi} ± 0.5	43.8
14	South	Pulped natural	Intermediate [a]	30.0^{hijkl} ± 0.6	13.6^{jklmn} ± 0.3	45.2
15	South	Pulped natural	Very good [a]	30.9^{ijkl} ± 0.4	11.8^{fghi} ± 0.1	38.3
16	South	Pulped natural	Very good [a]	22.6^{abc} ± 0.9	8.8^{ab} ± 0.1	39.1
17	Southest	Pulped natural	Very good [b]	30.3^{hijkl} ± 0.0	14.4^{lmno} ± 0.1	47.6
18	Southest	Pulped natural	Superior [b]	32.7^{lm} ± 0.7	15.7^{op} ± 0.3	48.0
19	Southest	Pulped natural	Very good [b]	26.5^{cdefgh} ± 0.4	11.8^{fghij} ± 0.1	44.3
20	Southest	Pulped natural	Good [b]	31.0^{ijkl} ± 0.6	15.7^{op} ± 0.2	50.4
21	Southest	Pulped natural	Minor [b]	29.8^{hijkl} ± 0.4	14.6^{mno} ± 0.3	49.0
22	Southest	Pulped natural	Good [b]	30.3^{hijkl} ± 0.1	14.6^{mno} ± 0.0	48.0
23	Southest	Pulped natural	Good [b]	24.7^{bcdef} ± 0.0	10.5^{bcdef} ± 0.0	42.7
24	Southest	Pulped natural	Very good [b]	27.6^{efghij} ± 0.1	12.5^{ghij} ± 0.1	45.1
25	Southest	Pulped natural	Very good [b]	31.0^{ijkl} ± 0.6	14.2^{klmno} ± 0.7	45.7
26	Southest	Pulped natural	Good [b]	32.6^{lm} ± 1.2	15.0^{nop} ± 0.7	46.1
27	Southest	Pulped natural	Superior [b]	25.4^{bcdefg} ± 0.5	11.3^{efgh} ± 0.5	44.3
28	Southest	Pulped natural	Superior [b]	$28.1^{efghijk}$ ± 3.0	12.9^{hijklm} ± 0.7	45.9
29	Southest	Pulped natural	Minor [b]	24.3^{bcde} ± 0.2	10.5^{bcdef} ± 0.1	43.1
30	Southest	Pulped natural	Minor[b]	28.9^{ghijkl} ± 1.7	13.2^{ijklm} ± 0.5	45.6
31	Southest	Pulped natural	Very good [b]	22.4^{ab} ± 1.0	11.1^{defg} ± 1.0	49.9
32	Southest	Pulped natural	Superior [b]	35.2^{m} ± 1.1	16.4^{p} ± 0.9	46.6

Mean of triplicates ± standard deviation. Mean in each column bearing the same letters are not statistically different ($P \leq 0.05$) from one another.
[a] Coffees from the State Contest Café Qualidade Paraná 2012 - IAPAR.
[b] National Contest Cup Excellence 2011- Brazil Specialty Coffee Association (BSCA).
[c] % of 5-CQA relative to the total chlorogenic acids.