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Correlation between cup quality and chemical attributes of Brazilian coffee

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This work is dedicated to the memory of our dear friend, colleague and mentor, Prof. Luiz Carlos Trugo, after his untimely death on November 20, 2004. His example will keep inspiring all who had the privilege of knowing him.

Abstract

Brazilian arabica coffee is classified for trading according to the quality of the beverage obtained after roasting and brewing. In the present study, Brazilian green and roasted coffee beans were investigated for possible correlations between cup quality and the levels of sucrose, caffeine, trigonelline and chlorogenic acids, determined by HPLC analysis. Trigonelline and 3,4-dicaffeoylquinic acid levels in green and roasted coffee correlated strongly with high quality. To a lesser extent, caffeine levels were also associated with good quality. On the other hand, the amount of defective beans, the levels of caffeoylquinic acids (predominantly 5-caffeoylquinic acid), feruloylquinic acids, and their oxidation products were associated with poor cup quality and with the Rio-off-flavor. The fact that similar correlations between cup quality and chemical attributes were observed in green and light roasted samples – the latter used for coffee cup classification – indicates that chemical analysis of green beans may be used as an additional tool for coffee quality evaluation.

Keywords: Coffee quality; Rio-off-flavor; Chlorogenic acids; Trigonelline; Caffeine

1. Introduction

Flavor is the most important criterion for coffee quality evaluation, and also one of the major motivations for consumer preferences (Cantergiani et al., 1999; Clarke, 1987, chap. 2). The assessment of coffee quality by both buyers and sellers in Brazil is based on the brewing method of steeping, which consists on pouring boiling water (∼150 mL) directly onto roasted and ground coffee (∼10 g; mild roast; fine grind) contained in a small cup and performing sensory (smell, flavor) evaluation after a few minutes (Clarke, 1987, chap. 2; Lingle, 1993). Classification is performed by a trained panel, and the beverage quality denominations, from best to worst, are: Strictly soft, Soft, Barely soft, Hard, Rioysh, Rio and Rio zona (Table 1). This determines the so called cup quality. The lowest quality coffees (Rioysh, Rio and Rio zona) are associated with the Rio off-flavor, usually described as a pungent, medicinal, phenolic or iodine-like flavor associated with a musty, cellarlike odor (Lingle, 1993; Spadone, Takeoka, & Liardon, 1990).

The presence of defects is also relevant in establishing Brazilian coffee quality, since they are associated with

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Table 1
Official classification of Brazilian coffee beverage (Bartholo & Guimarães, 1997)

Classification	Characteristics
Strictly soft	Very smooth flavor; slightly sweet; low acidity
Soft	Smooth flavor; slightly sweet
Barely soft	Smooth flavor, but with slight astringency
Hard	Astringent flavor; rough taste; lacks sweetness
Rioysh	Slight taste of iodoform or phenic acid
Rio	Strong unpleasant taste, reminding iodoform or phenic acid
Rio zona	Intolerable taste and smell

problems during harvesting and pre-processing operations. The term defect is used in reference to the presence of defective (black, sour or brown, immature, immature-black, bored, broken, etc.) beans and also of extraneous matter (husks, twigs, stones, etc.) in a given coffee sample (Clarke, 1987; Franca, Oliveira, Mendonça, & Silva, 2005; Franca, Mendonça, & Oliveira, 2005; Mazzafera, 1999). Black beans are those from over-ripened fruits. Sour beans are from fruits that are fermented on the ground or due to improper processing conditions. Immature beans come from immature fruits, immature-black are beans from immature fruits in which the skin is oxidized, and bored beans are those damaged by insect action. Even though defects are known to negatively affect coffee flavor, the total counting of defects alone cannot be used to accurately predict cup quality (Smith, 1985, (chap. 1)).

The chemistry of flavor development during coffee roasting is highly complex and not completely understood. Even though roasting process appears to be simple in terms of processing conditions, it is quite complex from a chemistry point of view, since hundreds of chemical reactions take place simultaneously. Examples include Maillard and Strecker reactions, degradation of proteins, polysaccharides, trigonelline and chlorogenic acids (De Maria, Trugo, Aquino Neto, Moreira, & Alviano, 1996). Sugars, particularly sucrose as the most abundant, will act as aroma precursors, originating several substances (furans, aldehydes, carboxylic acids, etc.) that will affect both flavor and aroma of the beverage. Trigonelline is a pyridine derivative, known to contribute indirectly to the formation of desirable aromas during roasting (Ky, 2001; Macrae, 1985, (chap. 4)). Caffeine, a xantine derivative, presents a characteristic bitter taste reported to be important to coffee flavor (Trugo, 1984). This compound has also been the subject of several investigations in view of its pharmacological effects (Azam, Hadi, Khan, & Hadi, 2003; Barone & Roberts, 1996; Macrae, 1985, Ribeiro-Alves, Trugo, & Donangelo (chap. 4); Ribeiro-Alves et al., 2003). Chlorogenic acids (CGA), a group of phenolic compounds that represent 6–12% of coffee constituents in mass (Farah, De Paulis, Trugo, & Martin, 2005), are known to be responsible for coffee pigmentation, aroma formation, and astringency (De Maria, Trugo, Moreira, & Petracco, 1995; Trugo, 1984). Furthermore, thermal degradation of chlorogenic acids during roasting will result in phenolic substances that contribute to bitterness (Clifford, 1985, chap. 5). The major CGA subgroups in coffee are the caffeoylquinic acids (CQA), feruloylquinic acids (FQA) and dicaffeoylquinic acids (diCQA) (Clifford & Wight, 1976; Trugo & Macrae, 1984). These compounds have received much attention lately due to various pharmacological activities observed in vitro and in animals (Farah et al., 2005).

Even though more than eight hundred volatile and non-volatile compounds have been already identified in coffee, the question of which constituents are the most relevant contributors to low cup quality coffee is controversial and far from being completely answered, especially in regard to the Rio-off-flavor. According to Spadone et al. (1990), 2,4,6-trichloroanisole and 2,4,6-trichlorophenol were identified as two of the components responsible for the Rio-off-flavor. While Amorim, Basso, Crocomo, and Teixeira (1977) have not observed a correlation between cup quality and the levels of polyamines, Oliveira, Franca, Glória, and Borges (2005) found higher levels of amines in lower quality coffee samples, comparing to those of good quality. Mazzafera (1999) and Franca et al. (2005) associated higher acidity with low cup quality, possibly due to the presence of defective coffee beans, specifically the ones that had undergone fermentation. Chagas (1994) observed a positive association between the levels of reducing and non-reducing sugars and cup quality. 2-Methylbutyraldehyde and 3-methylbutyraldehyde were described as two of the volatile compounds characteristic of green defective beans and low cup quality coffee blends (Cunha, 2005).

In view of the above, a more extensive investigation of chemical attributes of Brazilian coffees of different cup qualities is needed. Therefore, the objective of the present study was to investigate the existence of a possible correlation between cup quality and the content of some of the most important compounds in coffee: sucrose, trigonelline, caffeine and chlorogenic acids.

2. Material and methods

2.1. Samples

Arabica coffee samples classified as Soft, Hard, Rioysh, Rio and Rio zona, (Pinhal, São Paulo, Brazil) were provided by the Brazilian Association of Coffee Industry (ABIC). Samples of randomly selected beans were separated from each lot and the defective (black, sour, immature, bored) and non-defective beans were manually separated and weighted in order to determine the mass composition of defective beans for each lot.