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Quality of coffee cultivated in Campos Gerais, Minas Gerais

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ABSTRACT. Coffee quality can be defined as a set of physical, chemical, sensory and safety attributes that meet consumer taste preferences. *Coffea arabica* is the most cultivated species, accounting for 70% national and world production of coffee. The present study analyzed 6 coffee samples from 6 different regions in the municipality of Campos Gerais, subjected to the treatments raw and roasted, in order to assess their physical and chemical quality based on the parameters of titratable acidity, pH, moisture, soluble solids content and caffeine content. All the samples met the standard of at least one of the quality parameters studied. The best value of total acidity in roasted coffee was observed in the Grupiara region. The raw coffee of the Galo region presented the best quality as to the pH. The sample of the Prata region showed the highest caffeine content related to the quality of raw and roasted coffee, the best content for total acidity for raw coffee and the best pH value for roasted coffee. Therefore, the coffee of the Prata region is considered the best quality coffee analyzed in this study.

Keywords: *Coffea arabica*, physical and chemical analysis, raw coffee, roasted coffee.

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RESUMO. A qualidade do café pode ser definida por um conjunto de atributos físicos, químicos, sensoriais e de segurança que atenda os gostos dos consumidores. A espécie *C. arábica* é a mais cultivada e responsável por mais de 70% da produção nacional e mundial de café. Neste trabalho foram analisadas seis amostras de café originados de seis regiões distintas situadas no município de Campos Gerais, Estado de Minas Gerais, submetidas aos tratamentos cru e torrado com o objetivo de avaliar sua qualidade físico-química com base nos parâmetros de acidez total titulável, pH, umidade, teor de sólidos solúveis e teor de cafeína. Os resultados demonstraram que todas as amostras analisadas estão nos padrões de pelo menos um dos parâmetros de qualidade estudados. O melhor valor de acidez total no café torrado foi na região Grupiara. O café cru da região do Galo apresentou a melhor qualidade quanto ao valor do pH. A região do Prata apresentou o maior teor de cafeína relacionado à qualidade de cafés crus e torrados, o melhor teor para o parâmetro acidez total para o café cru e o melhor valor de pH quanto à qualidade do café torrado. Portanto, o café da região do Prata pode ser considerado o de melhor qualidade estudado neste trabalho.

Palavras-chave: *Coffea arabica*, análise físico-química, café cru, café torrado.

Introduction

Coffee industry has evolved over the last decade to meet market demand. High technology levels have been required by the coffee sector to increase productivity in Brazil, with a production estimated at 44.6 million bags in 2014, reducing costs and restricting the use of agrochemicals. Moreover, never before coffee quality has been so appreciated due to the increasing expansion of consumption of specialty coffees, about 12 million bags per year in Brazil (Silva, Rabelo et al., 2014).

Brazil, as a major producer and exporter of coffee, needs to deepen the knowledge about the fruit and its quality (Baliza et al., 2012). Seeking efficiency and excellence in quality, favoring the export market and investment in the domestic market (Jöet et al., 2010; Barbosa et al., 2012). Coffee quality can be influenced by climatic, genetic or sanitary factors during the diverse production phases (Silva et al., 2005). Losses are observed in postharvest, processing or during drying process, which is one of the key steps that result in quality loss, especially if it is poorly conducted and performed integrally in terraces (Camargo, 2010; Malerbo-Souza, Halak, 2012).

Several chemical compounds found in coffee beans are used, during and after roasting, through chemical processes, resulting in important constituents of the aroma and flavor of the drink (Franca, Mendonça, & Oliveira, 2005). The

chemical composition of coffee can change according to the climate, region, altitude, soil, species and others (Silva, Junior et al., 2014). Desirable and undesirable compounds with perceptible flavor and aroma can be formed depending on the chemical composition of coffee bean (Farah, Monteiro, Calado, Franca, & Trugo, 2006).

In this context, aiming to analyze the quality of coffee grown in Campos Gerais, Minas Gerais State, the present study investigated some physical and chemical characteristics of raw and conventionally roasted coffee samples produced and processed in conventional crops of small farmers in the region and marketed by a particular company of buying and selling coffee.

Material and methods

Raw material

This study analyzed samples of Arabica coffees from the harvest of 2011 purchased in a coffee trading company located in Campos Gerais, Minas Gerais State. Beans were received as raw and dried grains, from conventional crops, dried on brick yards (dry processing). All samples were from the municipality of Campos Gerais, at 843 m above sea level, and geographical coordinates 21°14'07" South latitude and 45°45'12" West longitude, with tropical climate of altitude. At the harvest time, the weather was dry with temperatures ranging from 9 to 25°C and rainfall of 9-23 mm.

All the experiment was performed in the Laboratory of Biochemistry and Food Science, Faculty of Science and Technology of Campos Gerais.

Experimental design

This was a completely randomized design (CRD) in a (2 x 6) factorial arrangement of 2 treatments (raw - ground, roasted - ground) and 6 regions of Campos Gerais, corresponding to the region where coffee was grown, namely: Galo, (GA) with humid tropical climate and 840 m altitude; Amoras (AM) with humid tropical climate and 810 m altitude; Sapezinho (SP) with humid tropical climate and 830 m altitude; Dois Paus (DP) with humid tropical climate and 845 m altitude; Grupiara (GR) with humid tropical climate and 832 m altitude and Prata (PR) with humid tropical climate and 855 m altitude, with 4 repetitions for each treatment.

Statistical analysis

The results were tested by analysis of variance (ANOVA), using the statistical software SISVAR (Ferreira, 2011). All statistical tests were performed at the 5% significance level.

Sample preparation

The samples were divided into two equal portions, one subjected to commercial medium roast (55-65 Agtron) and ground in a conventional Willy grinder; while the other was kept raw and subjected to crushing in Willy mill.

After treatment, all samples were stored in amber package hermetically sealed and kept in a dry, well-ventilated and dark room.

Moisture determination

The moisture content was determined by the gravimetric method of the Association of Official Analytical Chemistry (AOAC, 2005), which consists of water loss by dehydration at temperatures of 100 to 105ºC.

Preparation of aqueous extracts

For each sample, it was weighed 2 g coffee powder, which was mixed with 25 mL distilled water and allowed to rest for 48 hours under refrigeration, according to the Association of Official Analytical Chemistry (AOAC, 2005).

The resulting solutions were filtered through filter paper and insoluble parts soaked in additional 25 mL distilled water during the same time period. The new mixtures were filtered and the liquid obtained during both filtrations were combined resulting in the studied extracts. In total, 12 extracts were prepared, 6 from raw coffee powder and 6 from roasted coffee powder, for evaluation of pH, total solids and titratable acidity.

Chemical analysis

pH determination

pH was determined by potentiometry with a glass electrode, using a digital pHmeter QUIMIS, following the technique of AOAC (2005).

Total Titratable Acidity (ATT)

Total titratable acidity was determined by titrating the filtrate with a 0.1 M NaOH standard solution, according to AOAC (2005). The results were expressed as g of total acids per 100 g coffee powder.

Total Soluble Solids (SST)

Total soluble solids were determined using a digital refractometer (Atago, PR-100 Palette) with automatic temperature setting. Results were expressed in percentage of soluble solids per 100 g coffee powder, according to AOAC (2005).

Determination of caffeine

Caffeine was determined by acid extraction, that is, there is a selective carbonization of organic matter in the sample with sulfuric acid releasing caffeine that was later extracted using chloroform according to the method of AOAC (2005). Results were obtained by spectrometer at 320 nm and expressed in mg caffeine per 100 g solution.

Results and discussion

Total Titratable Acidity (ATT)

The values of total titratable acidity of coffee beans can vary according to fermentation levels occuring in the grains, with the different maturity stages and can represent an auxiliary analysis for assessing the quality of the coffee beverage. The total titratable acidity (ATT) of coffee beans has an inverse relationship with the coffee beverage quality, because better quality coffees have lower total titratable acidity (Martinez, Poltronieri, Farah, & Perrone, 2013).

The values of titratable acidity (Table 1) were significantly different between raw and roasted treatments only for Grupiara (13.0 0.1 M NaOH 100 g^{-1} for raw coffee and 10.7 0.1 M NaOH 100 g^{-1} for roasted coffee) and Prata (21.3 0.1 M NaOH 100 g^{-1} for raw coffee and 8.0 0.1 M NaOH 100 g^{-1} for roasted coffee).

Table 1. Mean total titratable acidity (0.1 M NaOH 100 g^{-1}) in different types of raw and roasted coffees.

Treatment/ region	Dois Paus	Galo	Prata	Amoras	Sapezinho	Grupiara
Raw	1.6aA	1.3aA	21.3cB	1.3aA	1.6aA	13.0bB
Roasted	0.9aA	1.1aA	8.0bA	1.1aA	0.8aA	10.7cA

*Means followed by different lowercase letters in the same row and uppercase letters in the same column are significantly different by Tukey's test at 5% significance.

Moisture

Values of moisture content in Table 2 showed significant interaction between raw and roasted treatments.

Table 2. Moisture (%) in different types of raw and roasted coffees.

Tratament/ region	Dois Paus	Galo	Prata	Amoras	Sapezinho	Grupiara
Raw	9.3aB	9.9cB	9.9cB	9.5bB	10.0cB	10.0cB
Roasted	1.9dA	2.0dA	1.5bA	1.4bA	1.6cA	1.2aA

*Means followed by different lowercase letters in the same row and uppercase letters in the same column are significantly different by Tukey's test at 5% significance.

In raw coffee, the lowest average moisture was observed in the sample Dois Paus (9.3%) followed by Amoras (9.5%) and the samples Galo (9.9%), Prata (9.9%), Sapezinho (10.0%) and Grupiara (10.0%), which showed no significant differences to each other.

Moisture content of raw coffee registered in this study is within the recommended range by the Normative Instruction 8 of June 11st, 2003, the Ministry of Agriculture, which states that the moisture content of processed coffee (raw bean) may not exceed the maximum of 12.5% (Brasil, 2003).

During the drying of coffee, water content is reduced from 60% to close to 11% (Mendonça, Franca, & Oliveira, 2007). The reduction of water in the fruit provides safe storage conditions for long periods in order to minimize the respiration rate and the risk of oxidation, fermentation and development of microorganisms (Isquierdo, Borém, Oliveira, Siqueira, & Alves, 2012).

In roasted coffee, lower moisture was observed in Grupiara (1.2%) followed by Amoras (1.4%) and Prata (1.5%), and subsequently Sapezinho (1.6%) and the samples of Dois Paus (1.9%) and Galo (2.0%).

The values found in this experiment are within the range allowed by ANVISA (National Health Surveillance Agency), which states that roasted coffee must contain a moisture content of at most 5.0% (Brasil, 2005).

pH

Changes in pH caused by roasting can be of great importance in the acceptance of the product by the consumer. The pH is one of the quality attributes that helps professionals to classify a coffee as palatable without excess bitterness or acidity among other coffees (Franca et al., 2005).

The pH values found in the experiment are listed in Table 3. There were significant differences between samples and treatments, except for the sample of Amoras.

Table 3. Mean pH in different types of raw and roasted coffees.

Tratament/ region	Dois Paus	Galo	Prata	Amoras	Sapezinho	Grupiara
Raw	5.8cA	6.0dA	5.6aA	5.9cA	5.4aA	5.8bA
Roasted	6.2bB	6.2bB	6.3bB	5.9aA	6.1aB	6.2bB

*Means followed by different lowercase letters in the same row and uppercase letters in the same column are significantly different by Tukey's test at 5% significance.

In raw coffee, the lowest pH values were verified in the samples of Prata (5.59) and Sapezinho (5.4), followed by Grupiara (5.75), and subsequently Dois Paus (5.84) and Amoras (5.87) and Galo (6.0).

After roasting, the lowest pH values were obtained for Amoras (5.92) and Sapezinho (6.1), followed by Amoras (6.17), Galo (6.20), Grupiara (6.20) and Prata (6.27).

Fernandes, Pereira, Pinto, Nery, and Pádua (2003) investigated the chemical components and concentrations of aqueous extracts of *Coffea arabica* and *Coffea conillon* in different growing seasons, and found for *Arabica* species, pH values (5.87 and 6.03) similar to those observed in this experiment.

Total soluble solids

This attribute represents the sugar concentration in coffee, and other compounds may also be present in small amounts: organic acids, vitamins, amino acids and certain phenolic pectins (Kleinwächter & Selmar, 2010).

The mean content of total soluble solids found in this experiment are described in Table 4, and showed significant differences between treatments (raw and roasted) and samples Galo, Prata, Amoras and Grupiara.

In raw coffee, the lowest contents of total soluble solids were registered in the sample of Prata (7.0%), followed by Sapezinho (10.6%), Dois Paus (11.2%), Galo (11.7%) and Amoras (13.5%) and then Grupiara (14.6%).

After roasting, the lowest content of total soluble solids was obtained in the sample of Sapezinho (10.3%), and subsequently Grupiara (11.8%), Prata (12.6%), Dois Paus (12.8%), Amoras (22.2%) and Galo (29.5%).

Table 4. Mean content of total soluble solids (%) in different types of raw and roasted coffees.

Tratament/ region	Dois Paus	Galo	Prata	Amoras	Sapezinho	Grupiara
Raw	11.2bA	11.7bA	7.0aA	13.5bA	10.6bA	14.6cA
Roasted	12.8aA	29.5cB	12.6aB	22.2bB	10.3aA	11.8aB

*Means followed by different lowercase letters in the same row and uppercase letters in the same column are significantly different by Tukey's test at 5% significance.

The mean content of total soluble solids found in this study are consistent with the value (20.31%) found by Santos, Chalfoun, and Pimenta (2009) who studied the influence of wet processing under different drying on the physical, chemical and physico-chemical characteristics of the raw beans.

Caffeine

The amount of caffeine in coffee is responsible for 10% of its bitterness, without direct and intense effects on the sensory quality of the drink (Bizzotto, Meinhart Ballus, Ghiselli, & Godoy 2013). The differences in these values may be attributed to both genetic and environmental characteristics. This may explain the differences in caffeine content of coffees from the same region (Vignoli, Bassoli, & Benassi 2011).

The mean content of caffeine of the evaluated coffees is presented in Table 5. There were significant differences between samples and treatments, with a reduction in caffeine content in all samples after roasting.

Table 5. Mean caffeine content (%) in different types of raw and roasted coffees.

Tratament/ region	Dois Paus	Galo	Prata	Amoras	Sapezinho	Grupiara
Raw	0.2aB	0.6dB	0.8eB	0.1aB	0.2bB	0.2c B
Roasted	0.1aA	0.4dA	0.7eA	0.1bA	0.3cA	0.1bA

*Means followed by different lowercase letters in the same row and uppercase letters in the same column are significantly different by Tukey's test at 5% significance.

In raw coffee, lower values of caffeine content were found in the samples of Amoras (0.14%) and Dois Paus (0.15%), followed by Sapezinho (0.19%), and subsequently Grupiara (0.23%), Galo (0.64%) and Prata (0.77%).

After roasting, the lowest content of caffeine was observed in the sample of Dois Paus (0.10%), followed by Amoras (0.11%) and Grupiara (0.12%), and subsequently Sapezinho (0.17%), Galo (0.35%) and Prata (0.71%).

Conclusion

Under the climatic, geographical and environmental conditions in which the study was conducted, it can be concluded that:

All the samples met the quality standard of at least one of the quality parameters studied.

The coffee of the Prata region presented the best value for the total titratable acidity for raw coffee and the best pH value for roasted coffee.

The sample of the Grupiara region exhibited the best value of titratable acidity for roasted coffee.

Raw coffee of the Galo region had the best quality with respect to pH.

The sample of the Prata region showed the highest caffeine content related to quality of raw and roasted coffees.

The coffee sample of the Prata region is considered the one with the best quality analyzed in this study.

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