

Sensory Profile and Chemical Composition of Specialty Coffees from Matas de Minas Gerais, Brazil

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Abstract

The aim of this work was to evaluate the sensory profile of specialty coffees, natural and pulped, from the region of Matas de Minas in the State of Minas Gerais, Brazil and correlate the sensory scores with the chemical composition of the grains. Twenty samples of Arabica coffee were assessed (10 Natural and 10 Pulped), as the sensory profile (Cup of Excellence) and sucrose content, bioactive compounds and fatty acids of raw beans. The processed pulped coffees stood out as the final scores. The attributes sweetness, acidity and flavor were important for the distinction of the pulped coffees, while natural coffees the determining attributes were body and acidity. The bioactive compounds and sucrose showed positive and negative correlation with the sensory attributes, respectively. The acids C14:0, C18:2 and C18:3, were relevant to the sensory distinction of natural coffees. The acids C18:0 and C20:2 showed positive correlation, and acids C18:2 and C18:3, negative, with the sensory attributes of the pulped coffees. The specialty coffees of the region of Matas de Minas feature distinct sensory profiles and it is possible to correlate them with the chemical composition of the grains.

Keywords: sensory attributes, coffee quality, post-harvest, multivariate analysis

1. Introduction

Coffee is the second most consumed beverage in the world, preceded only by water. This high consumption is due not only to the pharmacological functions produced by caffeine content and antioxidant compounds present in the drink, which beneficially influence human health, but also and mainly to the characteristic flavor of the product. The flavor and aroma of coffee are the most important features for the final quality of the drink, which depends on the chemical composition of the grains, influenced by genetic factors, environmental, agricultural, harvesting and post-harvest practices, storage, roasting and preparation methods (Alves et al., 2011; Borém et al., 2008; Mendonça et al., 2009).

With the advent of specialty coffee segment quality assessment methodologies have been enhanced with the quantification of attributes of the drink (taste, aroma, acidity, body, sweetness, clean drink, absence of flaws, balance, and finalization) for better characterization to the perceived nuances, and therefore, greater product differentiation (SCAA, 2015). In this sense, many works have been developed to understand the complexity that exists in the production of specialty coffees with specific and unique attributes (Borém et al., 2016; Silveira et al., 2016; Carvalho et al., 2016; Fassio et al., 2016; Figueiredo et al., 2015; Silva et al., 2014; Sunarharum et al., 2014; Scholz et al., 2013; Bertrand et al., 2006; Avelino et al., 2005). A method that has excelled as effective in research with specialty coffees is the use of statistical tools such as Principal Component Analysis, the Method of Content Analysis, the Decision Tree by Hierarchical Cluster Analysis by CHAID method, Artificial Neural Networks, Discriminant Analysis by Boosting method, among others, all featuring the most secure and reliable information about the quality of the coffee drink (Ramos et al., 2016; Sobreira et al., 2015; Ribeiro et al., 2016; Liska et al., 2015; DonFrancesco et al., 2014; Link et al., 2014).

As for the wine (Morlat & Bodin, 2006), the coffee is considered a product of terroir, i.e., its quality is directly related to soil and climate conditions where it is cultivated (Piccino et al., 2014; Silva et al., 2014) and the differentiation of cafes through this principle makes it possible to determine potential areas to produce specialty coffees and to characterize the type of coffee from these areas, exploring their potentialities (Silva et al., 2014). The region of Matas de Minas is in the State of Minas Gerais is one of many Brazilian regions with potential for production of better quality coffees. The region of Matas de Minas englobes the areas in the parallels 40°50' to 43°36' latitude S and 18°35' to 21°26' longitude W, and is characterized as mountainous at altitudes ranging between 600 and 1,200 meters and covers much of the northern portion of the geographic region of Zona da Mata of Minas Gerais and small part of the southern portion of the Vale do Rio Doce (Silveira et al., 2016; Ferreira et al., 2016; Scolforo et al., 2007). It is considered a producing source of quality coffees, situated in an area of Atlantic forest, with naturally sustainable production, marked by the predominance of family agriculture, by the direct and indirect economic and social impact, natural integration between man and forest, and cultural factors present in coffee production in the region. The result of the craftsmanship developed in this region are coffees with diversity of nuances and different flavors, that has been excelling in the specialty coffee market.

In this context, the objective of this work was to characterize the sensory profile of specialty coffee samples from the region of Matas de Minas, and by Principal Component Analysis plot correlation between the sensory attributes and the chemical composition of the grains.

2. Method

Twenty samples of special coffee were selected (*Coffea arabica* L.) from the region of Matas de Minas, and of this total, 10 samples from the “wet process – Pulped Coffee” category and 10 from the “dry process – Natural Coffee”. The samples were selected randomly from the result of the 10th Quality Contest of Minas Gerais.

The encoding, the municipality, the form of processing and final grade for each of the samples are shown in Table 1.

Table 1. Municipality and processing of twenty specialty coffees from Matas de Minas, Brazil

Sample Codes	Municipality	Processing	Final Score
01CD	Espera Feliz	Pulped	84.92
02CD	Espera Feliz	Pulped	82.58
03CD	Manhuaçu	Pulped	83.08
04CD	Araponga	Pulped	83.67
05CD	Espera Feliz	Pulped	86
06CD	Espera Feliz	Pulped	86.6
07CD	Espera Feliz	Pulped	85.5
08CD	Espera Feliz	Pulped	83.6
09CD	Espera Feliz	Pulped	83.4
10CD	Mutum	Pulped	82
11NAT	Ervália	Natural	83.82
12NAT	Espera Feliz	Natural	83.45
13NAT	Manhuaçu	Natural	82.8
14NAT	Santa Margarida	Natural	82.73
15NAT	Araponga	Natural	82.64
16NAT	Manhuaçu	Natural	82.27
17NAT	Espera Feliz	Natural	81.72
18NAT	Santa Margarida	Natural	81.36
19NAT	Manhuaçu	Natural	81.27
20NAT	Araponga	Natural	80.54

2.1 Sensory Analysis

The Sensory analysis was developed during the 10th Quality Contest of Minas Gerais, held in the Center of Technology and Quality of Coffee at the Universidade Federal de Lavras, using the *Cup of Excellence – CoE* methodology adopted by the Brazilian specialty coffee Association (BSCA, 2016). Fourteen trained tasters

evaluated five cups of each sample as the following attributes: clean drink, sweetness, acidity, body, flavor, aftertaste, balance, overall quality and final score. The coffees that have scored 80 points or more were classified as specialty coffees. The attributes sweetness, flavor, aroma, body and final score, were statistically analyzed, because these are the main responsible for the distinction of different sensory profiles of coffee.

2.2 Sample Preparation

The samples were placed in paper coated with polyethylene packing, and stored in cold chamber to 16 °C after the sensory rating. For performing chemical analysis, samples of raw beans were milled into sample mill IKA® A11basic for about 1 minute with the addition of liquid nitrogen to make it easier to grind and avoid the oxidation of the samples. The following were placed in falcon pipes and stored in freezer, at temperature of -20 °C, until the completion of the chromatographic analyses.

2.3 Chromatographic Analysis

2.3.1 Caffeine, Trigonelline and cqa-5

Extraction of bioactive compounds caffeine, chlorogenic acid (cqa-5) and trigonelline has been carried out per the methodology proposed by Malta and Chagas (2009). These compounds were determined simultaneously, using high-performance liquid chromatography (HPLC). The system operated with injection valve Prominence Shimadzu model SIL-20AHT, with fixed loop of 20 µl and Shimadzu processor. We used reverse phase column C18 Shim-pack CLC-ODS (M), Shimadzu (5 µm, 150 mm × 4.6 mm), with pre-column of 4 µm. Elution was isocratic with mobile phase consisting of methanol:acetic acid:water (25:0.5:74.5), flow rate of 1 mL/min, at 30 °C. The final levels of caffeine, trigonelline and cqa-5 were expressed in g 100 g⁻¹ (b.s) based on the standard curve of each compound reviewed

2.3.2 Sucrose

It was followed the proposed by Murkovic and Derler (2006) for analysis of sucrose. The Liquid Chromatograph used consisted of a pump LC-10AD (Shimadzu), Refractive Index detector RID-10A (Shimadzu), Rheodyne injection valve and Star data acquisition system 5.5 (Varian). The samples and standards solutions were analyzed in 2 columns in series: Nucleosil C18-5 µm 250 mm × 4 mm (Supelco) and Discovery HS F5 150 mm × 4 mm (Supelco). The mobile phase was Milli-Q water at room temperature and flow of 1.0 mL/min and 20 µL of injection volume. The final content of sucrose was expressed in g 100 g⁻¹ (b.s.) based on standard curve of sucrose.

2.3.3 Fatty Acids

The fatty acids were extracted from samples Folch et al. (1957). The analyses were conducted on gas chromatograph model GC-17 A Flame Detector (FID) (Shimadzu). For registration and analysis of Chromatograms, the appliance is connected to a computer, using the program GC Solution. The compounds were separated and identified on a Carbowax capillary column (30 m × 0.25 mm) in Split System = 5, and nitrogen gas with linear speed programmed to 37.8 cm/s. The injector and detector temperatures were isothermally controlled at 220 °C and 240 °C. The initial temperature of the column was to 200 °C (maintained by 2 minutes), increase by 4 °C per minute until it reached 240 °C for a total of 20 minutes of analysis. The gas flow of drag in column was of 1.0 mL/minute. The identification of the compounds was performed through the retention time of the corresponding standard and contents of each fatty acid has been expressed in g 100 g⁻¹ (b.s.).

2.4 Data Analysis

The sensory profile of the samples was analyzed in a simple diagram named Sensograma (Sobreira et al., 2015) considering the average value of the total scores and sensory attributes for samples of each type of processing, using the tasters as repetition.

The data were subjected to multivariate analysis to better understand the relationship between the sensory scores and the chemical compounds evaluated. We used the Principal Component Analysis (PCA) to the breakdown of samples, resulting in the grouping of points according to sensory scores and chemical variables. For this analysis, the statistical software R (R Development Core Team, 2016) was used.

3. Results and Discussion

3.1 Sensory Profile of Pulped Coffees (CD) and Natural Coffees (NAT)

The range of final score between the pulped coffees was high, ranging from 82 points to 86.6 points, even the samples in this category being mostly from the same municipality, *i.e.*, Espera Feliz (Table 1). This observation can be corroborated by the research of Silva et al. (2016), in which it was evaluated the influence of climatic conditions in the region of Matas de Minas on the quality of the coffees of 20 municipalities in the region, in

which the authors concluded that even in the same or similar climatic conditions the samples presented different scores for the quality of the drink.

The range of final score for the category natural coffees was from 80.5 to 83.8 (Table 1) ranging up to 3 points on the scale, which showed, therefore, uniformity for the final score among the coffees of this category. It is known that several factors influence the quality of the coffee drink, among them are the genotype, environment, processing, drying, storage, the roasting process and method of preparation (Carvalho et al., 2011; Alves et al., 2011; Clemente et al., 2015; Malta et al., 2013; Abreu et al., 2015; Ribeiro et al., 2009). Therefore, each isolated factor or interaction between them can provide the coffee different sensory profiles, resulting in no repetition of harvest, in both qualitative and quantitative aspect. The region of Matas de Minas was known for many years as a producer of low-quality natural coffees, mainly due to the accumulation of moisture and high temperature at sowing and drying, factors that contribute to fermentation processes that affect the quality of the product (Campanha et al., 2007; Barbosa et al., 2010). With the adoption and diffusion of new technologies for the processing and drying of coffee, many producers would adhere to the wet processing to improve the quality of the coffee.

Coffees with the same final score often show distinct scores for specific quality attributes (Sobreira et al., 2015). To analyze the balance of the scores of the sensory attributes of the samples we used Sensogramas in a graphical projection (Figure 1).

Cherry pulped coffee (Figure 1a), for the most part, are more balanced in scores of the sensory attributes. In General, the 06CD stood out from other coffees as compared to attributes sweetness (6.6), acidity (6.7) and clean drink (6.5), flavor and body attributes presented equal scores (6.2), the remaining attributes presented scores below 6.0. By contrast, the 10CD presented the lower scores of the sensory attributes evaluated with grades below 5.8, except to clean drink (6.0). In this case, it is important to notice that even the sample showing a clear drink in the cup, or without flaws, not necessarily the same will stand out compared to other attributes. The other samples showed very similar scores for all attributes. With these results, it should be noted that balanced and higher scores for the main attributes of the drink, sweetness, acidity and flavor, influenced positively on final score of pulped natural coffee drink of the region of Matas de Minas Gerais.

For the natural category (Figure 1b), notice that the sensory attributes scores are closer (most between 5.8-6.0) for most samples, overlapping the lines, except for three samples that presented the scores of sweetness, flavor, acidity and body out of the average. The 18NAT sample stood out with higher scores to the attributes sweetness (6.5), acidity (6.3) and flavor (6.5). The sample 16NAT presented the lowest values for the scores of acidity and body (5.8 and 5.6 respectively), the sample 12 NAT presented the lowest value for the attribute sweetness (5.69), and the sample 13NAT the lowest value for the flavor (5.7), followed by the 15NAT samples (5.8) and 17NAT (5.8). The body attribute was more pronounced in samples of natural coffee, mainly in the 15NAT samples (6.4) and 20NAT (6.4).

The score of the main sensory attributes of the quality of the drink (sweetness, acidity, flavor and body) were not the highest for the 11NAT sample. However, this sample presented similar scores for all attributes (average 6.0 points), a very valued feature in the market of specialty coffees, and maybe for this reason it obtained the best score in the natural category. Sobreira et al. (2015) observed that the scores of sensory attributes behave differently within groups of genotypes with similar or equal total scores also using "Sensograma".

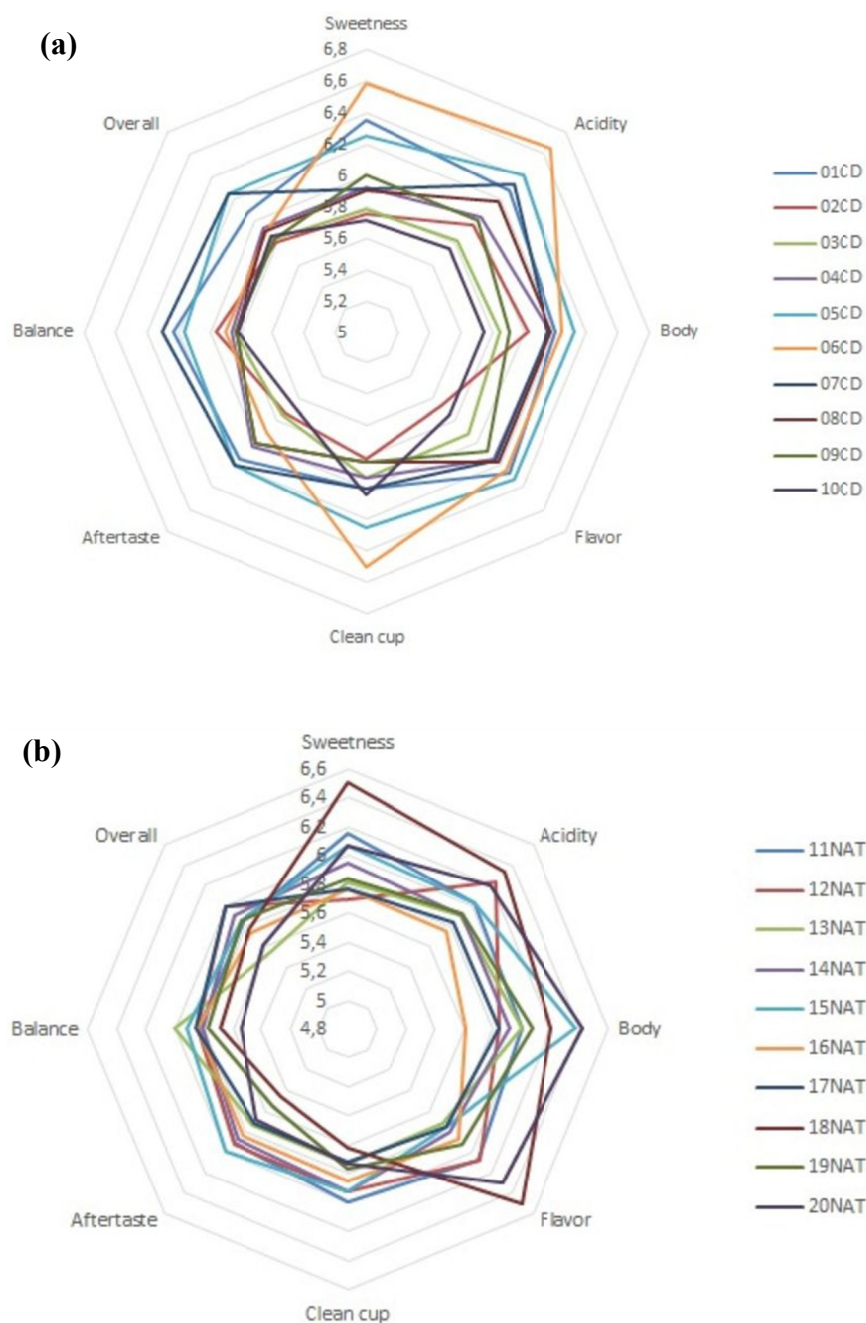


Figure 1. Sensograma of the average values of the scores of the sensory attributes of fourteen tasters to the Pulped (a) and Natural category (b)

3.2 PCA of the Sensory Attributes, Bioactive Compounds and Sucrose for Pulped and Natural

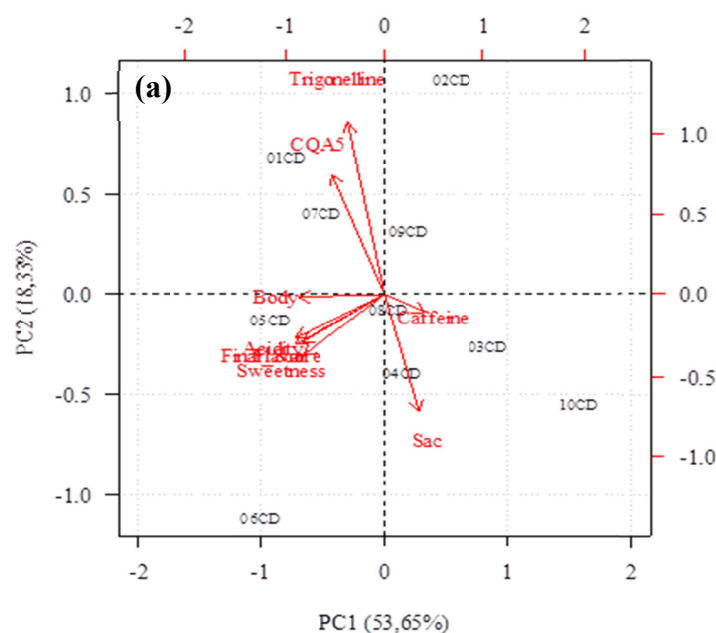
The average values in $\text{g } 100 \text{ g}^{-1}$, minimum and maximum obtained for caffeine compounds (1.26-1.49), trigonelline (0.99-1.22), cqa-5 (4.50-5.05) and sucrose (5.25-7.86) of the pulped coffees, and caffeine (1.27-1.47), trigonelline (1.04-1.26), cqa-5 (2.32-5.29) and sucrose (6.11-7.26) for natural coffees are in the range expected for raw beans of Arabica coffee (Farah et al., 2006; Franca et al., 2005; Figueiredo et al., 2013; Borém et al., 2016).

Figure 2a is a graphical representation of the results obtained from the PCA for the distribution of the pulped samples (CD) in function of the sensory scores and caffeine compounds, trigonelline, cqa-5 and sucrose, and Figure 2b is the graphical representation of the groups formed. The two first principal components explain 71.98% of the variability of responses. The sensory attributes and the final score were instrumental in the

formation of the PC1, and trigonelline compounds, cqa-5 and sucrose to the PC2. The caffeine parameter presented almost no explanation to the PC2 not being important for the explanation of this analysis (Table 2). Studies from Fassio et al. (2016), Figueiredo et al. (2013), Barbosa et al. (2012), and Avelino et al. (2005) also could not correlate directly the content of caffeine in drink quality in specialty coffees. However, Franca et al. (2005), and Farah et al. (2006), assessed the relation of caffeine with coffees of different sensory classes and found positive correlation between higher levels of caffeine in raw beans of Arabica coffee with the quality of drink. Therefore, caffeine is not a satisfactory parameter for evaluation of specialty coffees.

Thus, through correlation scores (Table 2) and the dispersion of the points in Figure 2b, it is possible to identify that the coffees allocated in the groups I and III, are the coffees with higher sensory scores and coffees allocated in Group II present intermediate and low sensory scores. Correlating this information with the composition of the coffees in trigonelline, cqa-5 and sucrose levels, it was possible to notice that there are coffees with high values of trigonelline and cqa-5 and low sucrose, and coffees with high values of sucrose and low trigonelline and cqa-5, within the three groups of samples. Therefore, for these specialty coffees, higher sensory scores correlate positively with sucrose, which is the case of the 06CD and 05CD coffees, and also with trigonelline and cqa-5 (01CD and 07CD), and the same occurred to the coffees of Group II. These results demonstrate the existing variability for chemical composition and quality of drink.

In the literature, it is exposed that higher sensory scores coffees correlate positively with the sucrose and trigonelline contents, and there is no satisfactory correlation with the phenolic compounds, such as chlorogenic acid and its isomers (Malta & Chagas, 2009; Barbosa et al., 2012; Mendonça et al., 2009; Bertrand et al., 2006; Farah et al., 2006; Figueiredo et al., 2013; Fassio et al., 2016; Borém et al., 2016). The trigonelline is an important precursor of volatile compounds that contribute to the desirable taste and aroma of roasted coffee, as well as the formation of chlorogenic acid taste astringent. Even in low concentrations, the impact of the chlorogenic acid in quality may be relevant, and lower levels of chlorogenic acids are associated with better quality of coffee drink (Perrone et al., 2012). There is not yet a right relationship that the sucrose content in raw beans of Arabica coffee is directly related to the quality of the drink, because it suffers considerable variation per species, variety and geographic origin (Knopp et al., 2006, Oosterveld et al., 2003). However, some studies are already achieving significant results in this correlation, since in the roasting process it is degraded to compounds relevant to the flavor and aroma of coffee. In a study of Borém et al. (2016) the authors observed that the sucrose content could discriminate specialty coffee genotypes in separate groups per score, and the coffees with higher sensory scores correlated positively with sucrose. The same was observed by Bertrand et al. (2003) and Decazy et al. (2003).



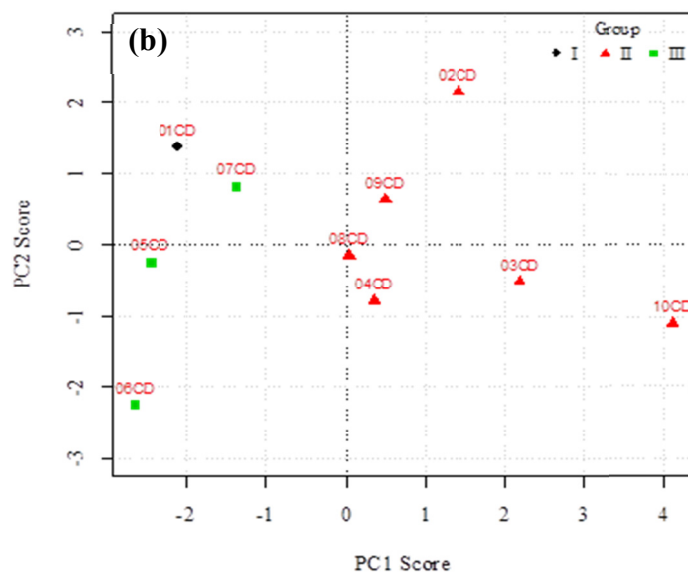


Figure 2. Biplot of the two first principal components (a) and groupings (b) to data of ten samples of pulped coffee, in function of the sensory scores and trigonelline, cqa-5, caffeine and sucrose compounds. CD = Pulped

For the category, natural coffees, the two first principal components explained 63.63% of the total variability of responses (Figure 3a). Figure 3b shows the separation of the groups formed from the dispersion of the points in the document, being possible to identify distinct groups of 3 samples.

The sensory attributes sweetness, acidity, body and flavor were instrumental in the formation of the PC1, and the sweetness, acidity and flavor attributes were responsible for separation of 18NAT coffees in Group II and the body attribute for the separation of the 20NAT coffee in Group III (Figure 3b and Table 2). The first main component also explained that the cqa-5 and sucrose correlate with the score of sensory attributes of natural coffees, however negatively. Soon, it was possible to confirm the proposed in the literature as to the negative correlation between the content of chlorogenic acid and the scores of the sensory attributes (Mendonça et al., 2009; Bertrand et al., 2006; Figueiredo et al., 20013; Fassio et al., 2016) but again it was not possible to correlate the contents of sucrose with the sensory attributes. Therefore, it is observed that the joint analysis of the data of bioactive compounds and sucrose for correlation with sensory scores values are not fully explanatory, indicating the possibility of studies with these variables separately.

The chemical compounds, along with the body, were the main parameters responsible for the formation of the PC2. There was the formation of two pairs of variables, the first couple (trigonelline and sucrose) influencing positively in the body of the drink and the second pair (cqa-5 and caffeine) negatively influencing the body attribute (Table 2). Borém et al. (2016) also observed the body being an important attribute to discriminate the sensory profile of samples of coffees with lower sensory score. The 20NAT sample of Group III, was the coffee that showed the highest score to body and consequently higher levels of trigonelline and sucrose and less of cqa-5 and caffeine, while the reverse was observed for the coffee 12NAT in Group I that presented low value for body and higher levels of cqa-5 and caffeine, and lower scores of sucrose and trigonelline (Figure 3b and Table 2). The body of the coffee drink is an attribute that is used to describe the physical, texture and density properties (Lingle, 2011; Illy & Viani, 2005). Carbohydrates play an important role in the perceived viscosity on coffee drink, the polysaccharides such as cellulose, arabinogalactan, and mannans contribute more substantially, and in a lesser proportion the carbohydrate glucose, fructose and sucrose (Buffo & Cardeli-Freire, 2004). In this way, one realizes that the sucrose is contributing to the formation of the body, corroborating with the authors cited above.

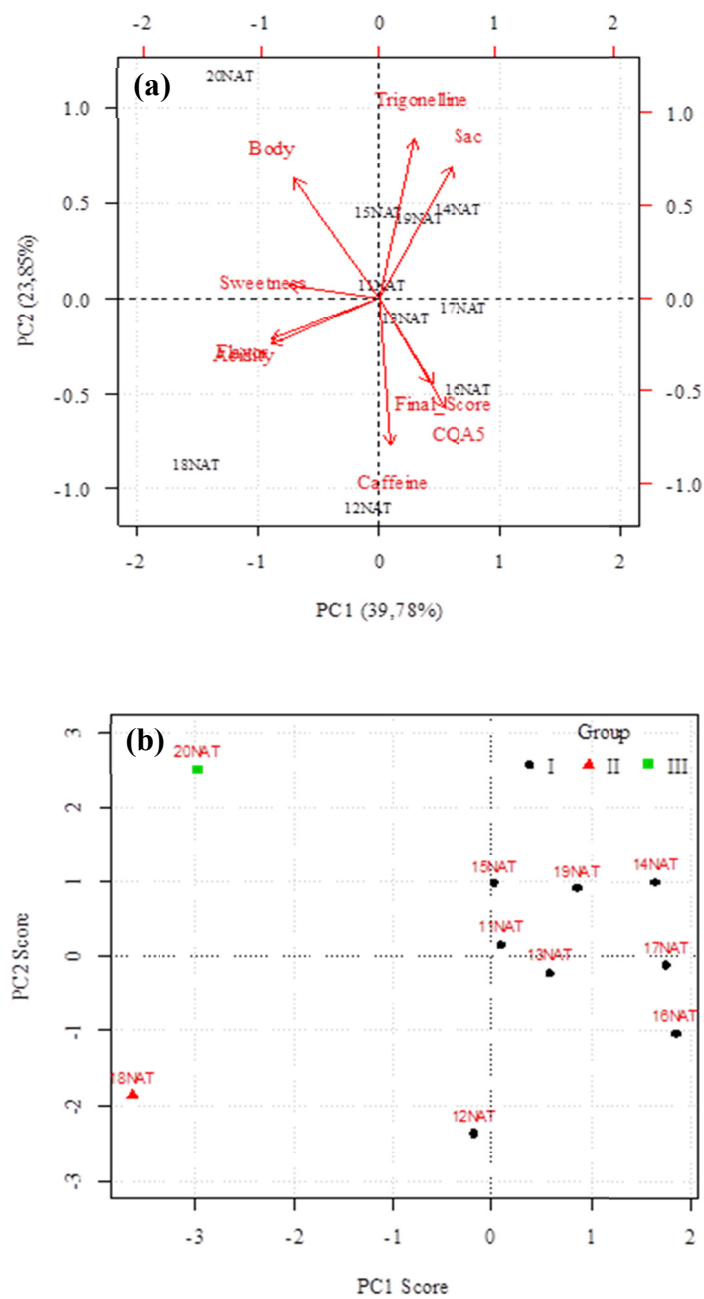


Figure 3. Biplot of the two first principal components (a) and groupings (b) to data of ten samples of Natural coffee, in function of the sensory scores and trigonelline compounds, cqa-5, caffeine and sucrose. NAT = Natural

Table 2. Correlations between the parameters assessed with the first two principal components for pulped coffee and natural coffee

Parameters	Pulped Rank (CD)		Natural Rank (NAT)	
	PC1	PC2	PC1	PC2
	Correlation*	Correlation*	Correlation*	Correlation*
Sweetness	-0.85	-0.29	-0.75	-0.75
Acidity	-0.94	-0.21	-0.89	-0.89
Body	-0.91	-0.01	-0.70	-0.70
Flavor	-0.86	-0.23	-0.89	-0.89
Final_Score	-0.93	-0.24	0.43	0.43
Trigonelline	-0.39	<i>0.84</i>	0.28	0.28
CQA5	-0.54	<i>0.59</i>	<i>0.53</i>	<i>0.53</i>
Caffeine	0.41	-0.08	0.09	0.09
Sac	0.35	-0.57	<i>0.60</i>	<i>0.60</i>

Note. * Variables in bold and italic indicate groups of variables to be formed, characterized by variables whose correlation with the principal component are high and with the same signal.

3.3 PCA of the Sensory Attributes and the Fatty Acids for Pulped and Natural Coffees

The average values in g 100 g⁻¹, minimum and maximum, obtained for the seven fatty acids found in this study for pulped: C14:0 (1.59-4.81), C16:0 (38.36-40.74) C18:0 (4.31-6.71), C18:1 (5.97-8.18), C18:2 (50.20-56.51), C18:3 (0.99-1.27), C20:2 (1.27-2.18), and to natural: C14:0 (2.36-5.43), C16:0 (37.9-40.51), C18:0 (4.81-6.72), C18:1 (6.67-8.12), C18:2 (48.31-54.39), C18:3 (0.91-1.48), C20:2 (1.39-2.55), are situated in the range expected for raw beans of Arabica coffee (Martin et al., 2001; Figueiredo et al., 2015; Bertrand et al., 2008).

As shown in Figure 4a, the two first principal components feature 75.76% of the total variability of response of the PCA and the formation of 3 groups of samples per the attributes and final score and of the fatty acids found in the pulped coffees (Figure 4b).

The PC1 has been set from the parameters sweetness, acidity, body, flavor, final score and also by fatty acids C18:0, C18:2, C18:3 and C20:2, which shows that for the coffees of the pulped category, these fatty acids have correlation with the quality of the drink, and the acids C18:0 and C20:2 correlate directly with the scores of the attributes and with the final score of coffees, and were instrumental to group the coffees with higher final scores in groups I and III, while the acids C18:2 and C18:3 showed negative correlation with these characteristics and were instrumental in allocating the coffees with lower final score in Group II (Table 3, Figure 4b).

The contents of lipids found in various natural sources gives the foods distinct flavor profiles by the presence of characteristic volatile compounds, as by-products of lipid oxidation (Damodaram et al., 2007). Fatty acids can contribute to subtle and pleasant scores of flavor and are the main compounds responsible for texture and mouthfeel of the coffee drinks (Oestreich-Janzen, 2010). Corroborating with the present study, Figueiredo et al. (2015) could correlate the contents of four fatty acid (C20:0, C18:1t, C18:0 and C14:0) with the sensory characteristics of specialty coffees, and Fassio (2014) also observed negative correlation between linoleic acid (C18:2) and the sensory attributes of plant varieties of Arabica coffee.

For the formation of the PC2, it is observed that the fatty acids C18:0, C14:0, C18:1, and C20:2, and the acidity showed strong correlation, however the fatty acid C14:0 presents positive correlation and other fatty acids negative correlation. Therefore, these four fatty acids influenced in defining the acidity of coffees of pulped category. From the above and analyzing the Figure 4b, you can see that the fatty acids C18:0, C14:0, C18:1, and C20:2 were important for the separation of coffees of lower and intermediate acidity scores (09CD, 10CD, 03CD, 08CD and 02CD) within the Group II. It is reported that the lack of balance of flavor in foods is associated with low levels of saturated fatty acids (Banks et al., 2007) and unsaturated fatty acids, due to the ease of suffering oxidation and produce rancid flavor, can collaborate to the decrease of food quality (Jham et al., 2008). In this study, it was observed that both saturated fatty acid (C18:0) and the unsaturated fatty acid (C20:2) are able to discriminate pulped coffees by the sensory scores of the attributes and final score.

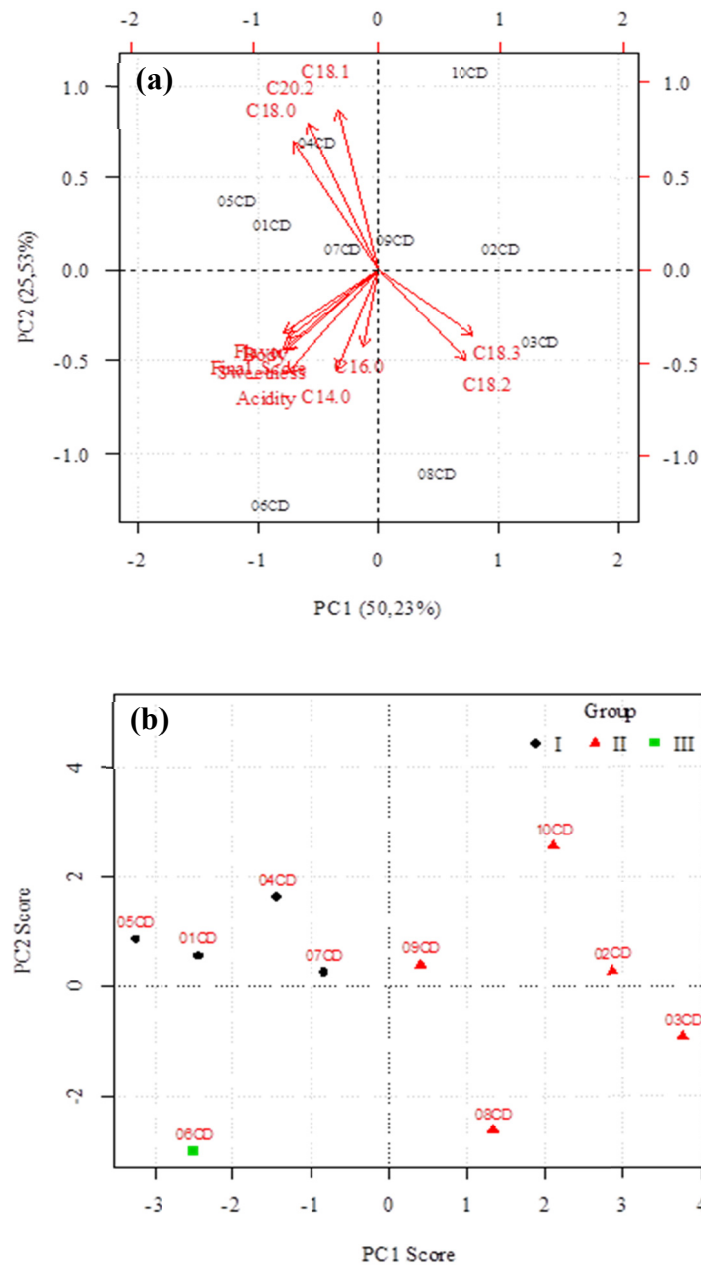


Figure 4. Biplot of the two first principal components (a) and groupings (b) to data of ten samples of Pulped coffee, in function of the sensory scores and of the fatty acids. CD = Pulped. C14:0 = myristic acid, C16:0 = palmitic acid, C18:0 = stearic acid, C18:1 oleic acid, C18:2 linoleic acid, C18:3 = linolenic acid, C20:2 = arachidonic acid

For the category, natural coffees, the two first principal components showed 60.74% of the variability (Figure 5a), and there was the separation of the coffee in three distinct groups as shown in Figure 5b.

The attributes sweetness, acidity, body, flavor and fatty acids C14:0 and C18:0 were instrumental in the formation of the PC1, however these parameters showed negative correlation for this component, that is, coffees in the natural category from Matas de Minas, with high scores for the sensory attributes present low rates for the fatty acids C14:0 and C18:0. Demonstrating again that the hypothesis of a correlation between saturated fatty acids and sensory quality (Banks et al., 2007; Jham et al., 2008) does not apply to specialty coffees of the region of Matas de Minas, evaluated in this work. For PC2 is possible to observe that the fatty acids C14:0, C18:0, C18:1, C18:2, C18:3 and C20:2 were instrumental for its formation, and the fatty acids C14:0, C18:2 C18:3 and correlate with each other, and the same is true among the acids C18:0, C18:1, and C20:2 (Table 3).

It is observed in the Figure 5b and by scores of PC1 and PC2 (Table 3) that attributes sweetness, acidity, body and flavor were instrumental in the separation of the sample 18NAT in Group III, along with the fatty acids C14:0, C18:2 and C18:3. These fatty acids can be classified as important for the definition of the sensory attributes of the category Natural coffee. The fatty acids C14:0, C18:0, C18:2 and C18:3 were responsible for the Group II with samples 17NAT and 19NAT, which are coffees with lower sensory attributes. The coffees allocated in Group I can be considered as those which showed correlation with all the fatty acids evaluated in this study. The fatty acid composition of coffee depends on several factors, such as the species, variety, cultivation environment, storage of grain, beverage preparation (Amaral et al., 2006). The content of fatty acids has been shown to be an important tool in the differentiation of specialty coffees, a fact observed in the results obtained by various authors (Avelino et al., 2005; Figueiredo et al., 2015; Bertrand et al., 2008; Fassio, 2014).

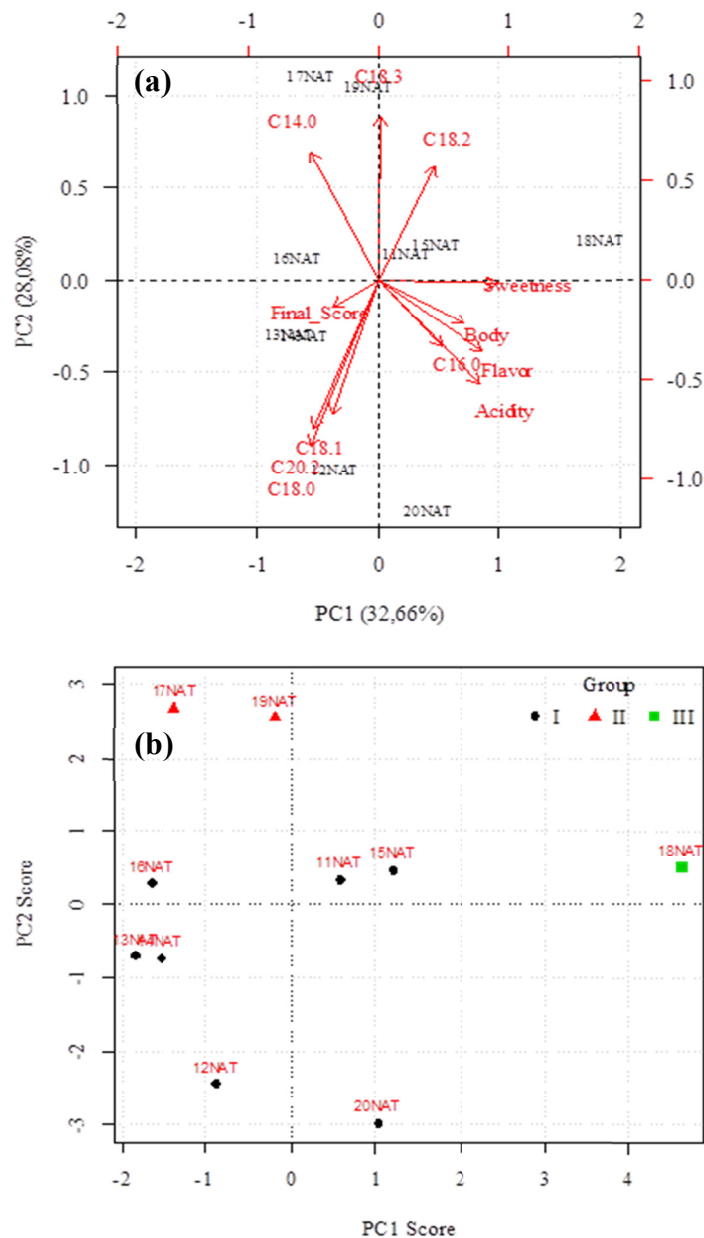


Figure 5. Biplot of the two first principal components (a) and groupings (b) to data of ten samples of Natural coffee, in function of the sensory scores and of the fatty acids. NAT = Natural. C14:0 = myristic acid, C16:0 = Palmitic acid, C18:0 = stearic acid, C18:1 oleic acid, C18:2 linoleic acid, C18:3 = linolenic acid, C20:2 = arachidonic acid

Table 3. Correlations between the parameters assessed with the first two principal components for Pulped Coffees and Natural Coffees

Parameters	Pulped Rank (CD)		Natural Rank (NAT)	
	PC1	PC2	PC1	PC2
	Correlation*	Correlation*	Correlation*	Correlation*
Sweetness	-0.82	-0.40	0.91	-0.01
Acidity	-0.81	-0.51	0.76	-0.49
Body	-0.80	-0.34	0.65	-0.21
Flavor	-0.84	-0.31	0.79	-0.34
Final_Score	-0.84	-0.39	-0.34	-0.12
C14:0	-0.36	-0.49	<i>-0.51</i>	<i>0.61</i>
C16:0	-0.12	-0.38	0.48	-0.31
C18:0	-0.76	<i>0.63</i>	<i>-0.51</i>	-0.79
C18:1	-0.35	<i>0.78</i>	-0.34	-0.64
C18:2	<i>0.79</i>	-0.45	0.42	<i>0.54</i>
C18:3	<i>0.85</i>	-0.32	0.01	<i>0.78</i>
C20:2	-0.62	<i>0.72</i>	-0.49	-0.71

Note. * Variables in bold and italic indicate groups of variables to be formed, characterized by variables whose correlation with the principal component are high and with the same signal.

4. Discussion

Many agronomic studies are conducted to differentiate coffee-producing sources, however little is known about the potential of the region of Matas de Minas, to produce specialty coffees. Our study showed that the specialty coffees of the region of Matas de Minas feature distinct and characteristic sensory profiles for the two processing categories evaluated. The attributes sweetness, acidity and flavor were important for the grouping of pulped coffees, while the body attribute was decisive for the grouping of natural coffees. From the PCA, it was possible to correlate the sensory attributes with the chemical composition of the grains, which had not yet been carried out with the coffees of the given region. The use of wet processing for the region of Matas de Minas is still the best option for specialty coffees, since these are still standing out and showing very balanced sensory profiles. Additional studies may be performed to improve results with larger sets of representative samples for each category.

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