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The beverage quality of Conilon coffee that is kept in the field after harvesting: Quantifying daily losses

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In search to maintain the coffee quality, the period of time for which the coffee is kept in the plantation after harvest (waiting transportation for the processing site) is one of the several factors that deserves scientific attention. This experiment aimed to identify and quantify losses of beverage quality suffered by Conilon coffee due to the time being kept in the field after harvesting, as an attempt to determine if the permanence of the bags in the plantation after harvest is possible before it causes detrimental effects over characteristics of beverage quality. The experiment followed a completely random design, with 8 treatments and 4 repetitions, using standardized bags of mature fruits of Coffea canephora Pierre ex Froehner that were kept in the plantation field for periods of 0, 1, 2, 3, 4, 6, 8 or 10 days after harvest. Samples from each bag were sent to chemical analyses, and triplicate samples of the processed coffee were sent to three separated sensorial analyses, each one performed by a different laboratory to asset the quality score and traits of the beverage. The results showed that the beverage quality suffers considerable losses due to the time of bags being kept in the field after harvesting. For many quality parameters, the detrimental effects of the permanence at fields start from the very first day, causing reduction of the quality score of the beverage and lowering the classification of the coffee.

Key words: Coffea canephora, harvest, flavor, aroma, time.

INTRODUCTION

Being one of the most popular beverages worldwide, coffee is also the most important agricultural commodity, this product is only less valuable than petrol, regarding the amount of financial value traded (Sunarharum et al., 2014). In addition, the coffee market has been constantly growing in the past years, with an annual growth of 2.4%, with the consumption (149.8 million bags) coming to surpass the production (143.3 million bags) (Ico, 2015). Associated to the increasing consumption of coffee worldwide, there also has been an increase in the search for special coffees, with high quality grains and intensified aroma and flavor, which make possible to obtain superior classes of beverage (Abic, 2010). This fact is related to the coffee consumer increasing the exigence regarding the quality standards, and also to the desire to track the system in which the coffee was produced, requiring environmental respect and social evaluation in the production of the special coffee (Navarini and Rivetti, 2010).

A high quality coffee has differentiated traits related to the chemical composition of the grains, which is affected for several variables along the cultivation and processing, such as the location of the crop, climate conditions, crop management, harvest technique, post-harvest processing, transporting and drying (Franca et al., 2005; Monteiro and Farah, 2012; Sunarharum et al., 2014). The period of time between the harvest of the mature fruits and their transport to the drying site, when the fruit mass is left in bags in the open plantation field, can promote the fermentation of the fruits due to the favorable conditions to enhance the biological processes, which may not only cause losses and damage to the grains, but also interfere in the quality of the beverage of this coffee. The coffee harvest is one of the stages of the production that requires the larger amount of manpower, which becomes limiting in traditional coffee growing regions. Therefore, the transport of the bags to the processing and drying site sometimes cannot be done promptly after harvesting, since some production systems may lack the time or manpower for the immediate process.

However, the traits of beverages made with grains of the specie *Coffea canephora* Pierre ex Froehner have not been focus of many scientific studies, since the coffee quality concept have been connected to *Coffea arabica* L. for many years. Therefore, the magnitude in which environmental factors can deplete its quality are yet to be elucidated, which very little scientific data being available in the subject. One of the best ways to determine and quantify losses caused by unwanted processes over the coffee quality is to perform standard sensorial analyses in the beverage (Monteiro and Trugo, 2005) and chemical analyses in the grains (Silva et al., 2009), which can be used to determine chemical variables with high correlation to sensorial parameters, such as potassium lixiviation and electric conductivity, helping to quantify the quality of the grains (Malta et al., 2005; Martinez et al., 2013; Pinto et al., 2002). The study aimed to identify and quantify losses of beverage quality that the Conilon coffee suffers due to the time of bags being kept in the field after harvesting, as an attempt to determine if the permanence of the bags in the plantation for a time after harvest is possible before it causes detrimental effects over characteristics of beverage quality.

MATERIALS AND METHODS

Characterization of area and coffee plantation

The experiment was conducted in the productive cycle of 2011 to 2012, in an 8 years old standardized plantation of *Coffea canephora* Pierre ex Froehner, with plants spaced 3.0 x 1.0 mm located in the municipality of Marilândia, in Espírito Santo State, Southeast region of Brazil. The altitude of the site is 202 m above sea level, the topography is hilly and the soil is classified as dystrophic Oxisol (Embrapa, 1997). The climate is tropical, classified as Aw (Köppen and Geiger, 1928), typically rainy from November to February; partially dry in March, April and October and dry from May to September, accumulating an average of 1,164 mm of annual rainfall and presenting average annual temperature of 24.2°C (13.9 to 33.5°C).

The plantation was established in 2004, and cultivated until the stabilization of the reproductive cycle, following the recommendations for Conilon coffee in Brazil (Prezotti et al., 2007; Ferrão et al., 2007; Ferrão et al., 2012) to manage nutritional and phytosanitary status of the plants. During the fourth harvest (when the plantation presented over 80% of fully ripe fruits), the fruits were manually collected and stored in raffia bags, which were weighted to create a homogeneous collection of bags of 50 kilograms each. The fruits were processed, roasted and milled after different periods of time to setup the treatments.

Experimental design

The bags were properly identified and randomly selected to be transported at 0, 1, 2, 3, 4, 6, 8 or 10 days after harvest. The experiment followed a completely random design, with 8 treatments (days staying in open field after harvest), and four repetitions. Each experimental plot consisted of one bag of 50 kg of green coffee.

Post-harvest processing and beverage quality

The fruits were transported to cement fields for post-harvest drying, and processed, following the recommendations for coffee in Brazil (Ferrão et al., 2007; Ferrão et al., 2012; Reis et al., 2012). After processing, samples of 50 homogeneous grains were weighed for standardization, immersed in 75 mL of purified water (reverse osmosis) and stored in a laboratory oven at 25°C for 5 h. The electric conductivity of each solution was measured using a digital conductivity meter (Sensoglass, SC-1800, precision: 0.05), and the results were expressed in $\mu S\ cm^{-1}\ g^{-1}$. The same solutions were used to determine the potassium lixiviation of the samples, using a flame photometer (Digimed, DM-62, precision: 0.001), and the results were expressed in ppm (Kryzyanowski et al., 1991; Malta et al., 2005; Pinheiro et al., 2012).

Homogeneous grain samples from each bag were roasted

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(Pinhalense, TMC-10) and milled (Pinhalense, MLV-5NA), and sent to three separated sensorial analyses, each one performed by a different laboratory to classified the mean beverage quality (triplicate samples from each bag), determining the sensorial variables (aroma, flavor, finalization, acidity, body, uniformity, balance, clean cup, sweetness, general aspect) of the beverage from each bag.

The cup test was performed by testers registered in Brazil (Ministério da Agricultura, Instrução Normativa Nº8), with three sub-samples of each experimental unit (Brasil, 2003).

Data analyses

The data were subjected to analysis of variance, and according with the presence of significant differences between treatments, the means were studied using regression analyses ($p < 0.05$), verifying the fit to linear models and selecting the models based on the statistical significance of the model, significance of the coefficients and r-square. All statistical tests were performed using the software GENES 5.1. (Cruz, 2013).

RESULTS

The variance analyses showed the existence of differences for most studied variables, the means were similar only for the one organoleptic characteristic of the beverage, which was the body. The coefficients of variation were under 10.89%, with this higher coefficient being observed for the clean cup test. Regarding the parameters of beverage quality, regression analyses presented fit to linear models of first degree for: aroma, flavor, finalization, balance, clean cup, sweetness and general score; and second degree for: acidity and uniformity (Figure 1). For the total score of the beverage quality, a fit to a first degree linear model was observed, while a second degree model was adequate to describe the behavior of the electric conductivity and lixiviation of potassium (Figure 2).

DISCUSSION

The aroma of the beverage is one of the major traits of coffee that is perceived by consumers as a critical characteristic to determine their liking and, as shown in Figure 1a, a linear loss in the aroma happened due to the time of the green coffee being kept in the field after harvesting. Fisk et al. (2012) affirms that different aroma profiles in coffee beverages can be originated from several sources along the cultivation processes, such as post-harvest processing type and aging before roasting, as well as seasonal variation and climatic conditions (Da Silva et al., 2005) and geographical locations (Risticevic et al., 2008). Regardless of presenting low aromatic traits, green beans contain several chemical precursors that will significantly contribute to determine the concentration of the complex compounds mixture that generate the aroma profile of the beverage, and the concentration of these chemical precursors is dependent on the origin and treatment of the coffee beans (Fisk et al., 2012).

According to Sunarharum et al. (2014), flavor is arguably the most important trait of the coffee beverage for the consumer and it is result of a series of complex chemical, biological and physical influences. The same authors describe that coffee flavor is generated still in the coffee plant, during the development of the fruits, and goes on throughout the harvest, processing and preparation techniques. Exposing the fruits to environmental conditions, such as humid conditions (Ahmad et al., 2003) and presence of microorganisms, during extended periods of time can cause the development of different flavor traits. Undesirable flavor traits linearly developed in this study (Figure 1b) due to the increase in the time of exposure to environmental conditions of the plantation after harvest. A high quality coffee should present enjoyable finalization, with adequate residual effect. The increase in the time kept in the plantation caused the finalization score to decrease linearly, losing near 0.07 score per day (Figure 1c). The influence of the plantation environment probably promoted biochemical alterations in the fruits that were detrimental to the maintenance of the aroma and flavor in the beverage which, in association with the less intense flavor and aroma, caused the reduction in the score for finalization of the beverage. The acidity presented a slight increase followed by the decrease of the score after the third day being kept at the plantation (Figure 1d). This short term increase in the acidity score along the first 3 days should not be explored, since the acidity is very important to define the coffee quality, but only in combination with sweetness, bitterness and aroma profile (Sunarharum et al., 2014), which presented daily decreased.

According to Bicho et al. (2013), with the increasing consumption worldwide, the interest of industry and scientists in the sensory properties has been growing. Recently, different sensory traits have been used to describe the attributes of the coffee beverage, including body, which is related to the tactile impression of texture, viscosity and mouthfeel of the beverage. This sensory trait was not affected by extending the period of time kept in the plantation (Figure 1e), but since the quality of gourmet coffees depends on the combination of flavor, body and aroma (Mori et al., 2003), the depreciation of the other beverage traits still resulted in beverage of lower qualities. The uniformity score is higher when the coffee is moved to processing right after harvesting, decreasing with time (Figure 1f), but presenting increase after 5 days. The uniformity of the mass with the longer periods of time is not passible of exploration, as the beverage becomes again more homogeneous, but uniform with low quality standards, consistently keeps the undesirable flavor in different cups of the sample tasted.

Regarding the balance, the linear decrease (Figure 1 g) observed with the increase of the time kept in the

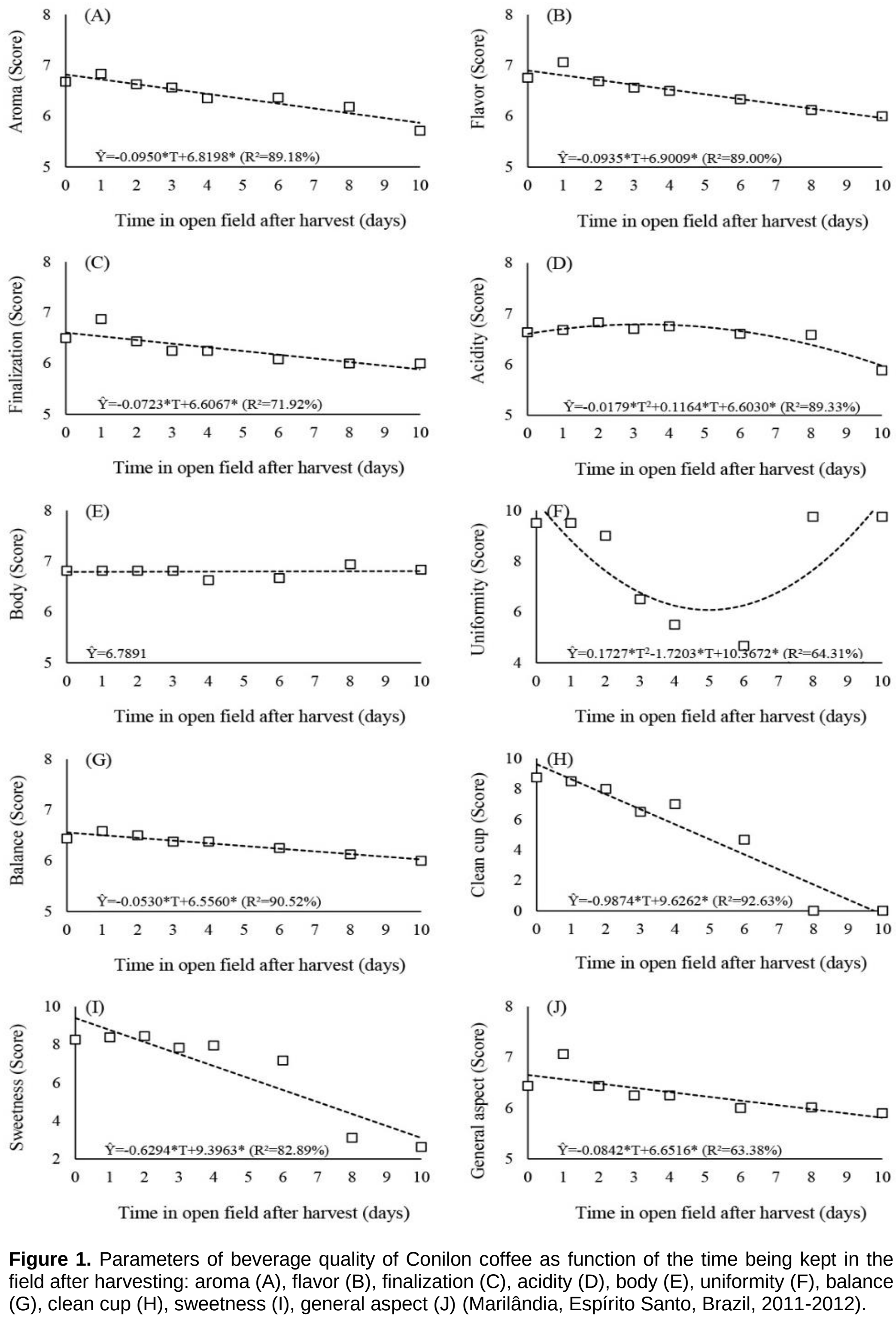

Figure 1. Parameters of beverage quality of Conilon coffee as function of the time being kept in the field after harvesting: aroma (A), flavor (B), finalization (C), acidity (D), body (E), uniformity (F), balance (G), clean cup (H), sweetness (I), general aspect (J) (Marilândia, Espírito Santo, Brazil, 2011-2012).

plantation shows the continued degradation of the quality, the decrease of balance is undesirable as this trait determines the pleasant sensation to the taste during the consumption and after tasting (Mori et al., 2003). Clean cup is related to the lack of negative interferences from first ingestion to final aftertaste, being commonly referred to as the "transparency" of the cup (Scaa, 2015a). This attribute presented a sharp decrease with the influence of the environmental factors over the coffee in the plantation, with losses already being found from the first

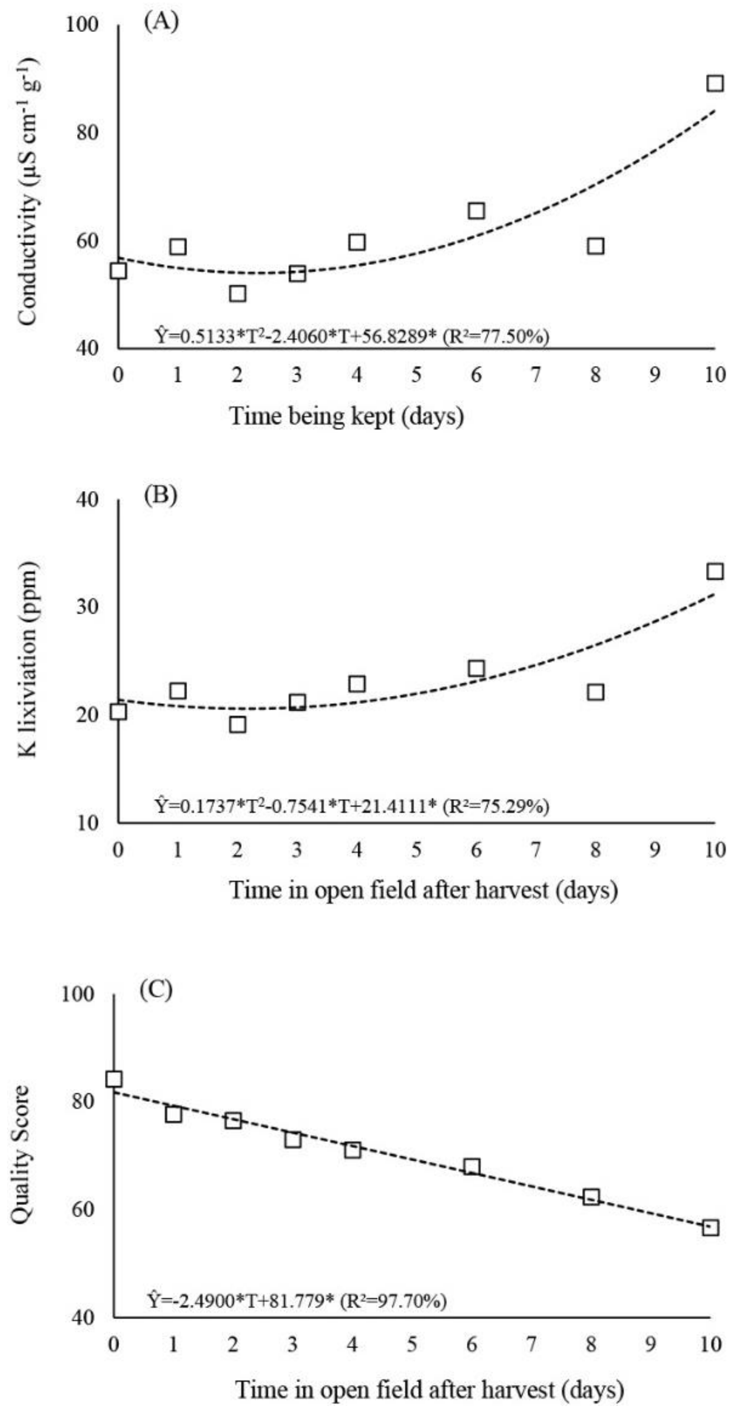

Figure 2. Characteristics of quality of Conilon coffee as function of the time being kept in the field after harvesting: electric conductivity (A), lixiviation of potassium (B) and score of the beverage (C) (Marilândia, Espírito Santo, Brazil, 2011-2012).

day being kept at the field (Figure 1h). A severe decline in sweetness was observed with the time being left at plantation (Figure 1i), it is possible that the slightly increase in the acidity caused by the treatments contributed to the initial decrease in the sweetness, as these attributes of the beverage often inversely correlated (Sunarharum et al., 2014). The sharp decrease continues even after the acidity past the minimum point and start increasing with the time kept in the plantation, this behavior may be related to the alteration of the compounds with the time which may be able to change the correlation between these traits as the coffee mass is kept under environmental conditions.

The general aspect or overall scoring aspect represents the integrated rating of the sample as perceived by specific panelists. The treatments caused decrease in this trait (Figure 1j), therefore, the coffee being kept for longer periods of time at plantation becomes less likely to meet the expectations, losing its capacity to express its character and to reflect qualities of original flavor (Scaa, 2015a). The chemical analyses of electric conductivity and lixiviation of potassium both presented similar behavior (Figure 2a and b), with increasing values as the time being kept at the plantation increased. These variables are correlated negatively to the beverage quality or the presence of defective grains (Malta et al., 2005; Prete, 1992; Romero et al., 2003). The final scoring of the coffee is calculated by first summing the individual scores given for each of the primary attributes and subtracting the defects. The total score can then be used to determine the quality classification of the coffee (Scaa, 2015a). The time being kept in the plantation alone caused the loss of classification from a specialty coffee of very good quality to a lower quality and not specialty class coffee (Figure 2c). The standards for scoring Robusta coffee proposed by Scaa (2015b) would indicate, considering a relative proportional loss, a decrease from the classification Fine coffee to a usual coffee from the time being kept in the plantation alone.

Conclusion

Chemical changes promote noticeable alterations in the coffee grains from the first day being kept in open field. The beverage quality of Conilon coffee suffers considerable losses due to the time of bags being kept in the field after harvesting. For many primary parameters of quality, the detrimental effects of the permanence at fields start from the very first day, causing reduction of the quality score of the beverage and lowering the classification of the coffee. Therefore, it is recommended to transport the harvested coffee out of fields as soon as possible to reduce the detrimental effects over the beverage quality.

Conflicts of Interests

The authors have not declared any conflicts of interests.

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