Sensory quality of parchment coffee subjected to drying at different air temperatures and relative humidities

Qualidade sensorial do café em pergaminho submetido à secagem em diferentes temperaturas do ar e umidades relativas

Calidad sensorial del café pergamino sometido a secado a diferentes temperaturas del aire y humedad relativa

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Abstract
Coffee quality is influenced by several factors, including the drying conditions. Therefore, this study evaluated the influence of the relative humidity of the drying air on the quality attributes of the coffee beverage. Arabica coffee (*Coffea arabica* L.) fruits were selectively harvested. The samples were dried in two steps in a fixed-bed dryer at an air speed of 0.33 ms^{-1}. In the first step, drying was performed until the water content was 0.428 g of water g of dry $matter^{-1}$, without controlling the dew point temperature. The second step was performed until the water content was 0.123 g of water/g of dry $matter^{-1}$, with dew point temperature control. A total of 11 treatments were tested involving nine combinations of dry bulb temperatures of 35 and 40 °C and dew point temperatures of 2.6, 10.8, 16.2 °C, plus two dryings at 35 and 40 °C dry bulb temperature without dew point temperature control. The samples were evaluated sensorially by three certified specialty coffee tasters. The data were subjected to principal component analysis. In the sensory analysis, the samples received total scores of 83.0 to 85.5 points. The drying conditions significantly influenced the quality of the coffee beverage. Drying at a dry bulb temperature of 40 °C and a dew point temperature of 16.2 °C (25% RH) is indicated for the production of higher quality coffees with a shorter drying time.
Keywords: *Coffee arabica*; Coffee quality; Sensory analysis; Principal component analysis; Coffee drying.

Resumo
A qualidade do café é influenciada por vários fatores, incluindo as condições de secagem. Portanto, este estudo avaliou a influência da umidade relativa do ar de secagem nos atributos de qualidade da bebida de café. Os frutos do café arábica (*Coffea arabica* L.) foram colhidos seletivamente. As amostras foram secas em duas etapas em secador de leito fixo a uma velocidade de ar de 0,33 ms^{-1}. Na primeira etapa, a secagem foi realizada até que o teor de água fosse de 0,428 g de água g de matéria $seca^{-1}$, sem controle da temperatura do ponto de orvalho. A segunda etapa foi realizada até o teor de água ser de 0,123 g água g de matéria $seca^{-1}$, com controle da temperatura do ponto de orvalho. Um total de 11 tratamentos foram testados envolvendo nove combinações de temperaturas de bulbo seco de 35 e 40 °C e temperaturas de ponto de orvalho de 2,6, 10,8, 16,2 °C, mais duas secas a 35 e 40 °C de temperatura de bulbo seco sem controle de temperatura de ponto de orvalho. As amostras foram avaliadas sensorialmente por três provadores de cafés especiais certificados. Os dados foram submetidos à análise de componentes principais. Na análise sensorial, as amostras receberam escores totais de 83,0 a 85,5 pontos. As condições de secagem influenciaram significativamente na qualidade da bebida do café. A secagem com bulbo seco de 40 °C e ponto de orvalho de 16,2 °C (25% UR) é indicada para a produção de cafés de maior qualidade e menor tempo de secagem.
Palavras-chave: *Coffee arabica*; Qualidade do café; Análise sensorial; Análise de componentes principais; Secagem do café.

Resumen
La calidad del café está influenciada por varios factores, incluidas las condiciones de secado. Por lo tanto, este estudio evaluó la influencia de la humedad relativa del aire de secado en los atributos de calidad de la bebida de café. Los frutos de café arábica (*Coffea arabica* L.) se recolectaron selectivamente. Las muestras se secaron en dos etapas en un secador de lecho fijo a una velocidad del aire de 0,33 ms^{-1}. En el primer paso se realizó el secado hasta que el contenido de agua fue de 0,428 g de agua g de materia $seca^{-1}$, sin control de temperatura del punto de rocío. El segundo paso se llevó a cabo hasta que el contenido de agua fue de 0,123 g de agua g de materia $seca^{-1}$, con control de temperatura en el punto de rocío. Se probaron un total de 11 tratamientos con nueve combinaciones de temperaturas de bulbo seco de 35 y 40 °C y temperaturas de punto de rocío de 2.6, 10.8, 16.2 °C, más dos secos a 35 y 40 °C de temperatura de bulbo seco sin control de temperatura del punto de rocío. Las muestras fueron evaluadas sensorialmente por tres catadores certificados de cafés especiales. Los datos se sometieron a análisis de componentes principales. En el análisis sensorial, las muestras recibieron puntuaciones totales de 83,0 a 85,5 puntos. Las condiciones de secado influyeron significativamente en la calidad de la bebida de café. El secado con bulbo seco de 40 °C y un punto de rocío de 16,2 °C (25% RH) está indicado para la producción de cafés de mayor calidad y tiempos de secado más cortos.
Palabras clave: *Coffee arabica*; Calidad del café; Análisis sensorial; Análisis de componentes principales; Secado de café.

1. Introduction

Arabica coffee is one of the main agricultural products that are marketed worldwide and plays a key role in the economy of several countries, especially those that are the largest producers (Do Carmo et al., 2020; Pereira et al., 2020; Ribeiro et al., 2017). Brazil, one of the largest producers of Arabica coffee, is responsible for more than 40% of its global production (USDA, 2020). According to the United States Department of Agriculture, in recent years, more than 10 million tons of Arabica coffee have been produced annually worldwide (USDA, 2020).

Coffee is marketed according to its qualitative parameters (Ferreira et al., 2018). Several studies have sought to correlate the chemical composition of coffee beans, such as the sugar, acid and volatile compound contents, with the sensory attributes of the beverage (Fernandes et al., 2014; Martins et al., 2019). The chemical composition of coffee beans depends on several factors, including those related to plant characteristics, such as species and variety; edaphoclimatic factors; harvesting, processing, drying, storage, grinding and transport conditions; and the method used to prepare the beverage for consumption (Alves et al., 2017; L. F. Ferreira et al., 2018; Pereira et al., 2020).

Among these steps, drying is a critical point in coffee bean processing (Alves et al., 2017). Drying consists of reducing the moisture content of the product, thus minimizing the chemical, enzymatic and microbiological reactions responsible for bean degradation during storage. If drying is improperly performed, undesirable changes may occur in the beans that impair important sensory attributes of the beverage, such as color, flavor and aroma. Therefore, the drying step should be optimized to preserve bean quality and minimize energy consumption and process time (Alves et al., 2017; de

Oliveira et al., 2015).

Sensory analysis is the main method for evaluating coffee quality (Alves et al., 2017). It is an empirical and subjective method in which trained tasters evaluate the beverage according to gustatory and olfactory perceptions. The aroma and flavor developed during bean roasting are two of the main sensory analysis parameters. During sensory analysis, scores are assigned to the 10 major attributes that make up the sensory profile of coffee. The sum of the individual scores of all attributes constitutes the final score, which represents the overall quality of the coffee (Lingle, 2011).

The objective of this study was to evaluate the influence of different relative humidities (RH) of drying air on the sensory quality of the coffee beverage.

2. Methodology

2.1 Materials

Coffee fruits (*Coffea arabica* L. cv. Catuaí Vermelho) were harvested manually in Nepomuceno (21°12'19.5"S latitude; 45°11'27.4" W longitude; 980 m altitude), Brazil. The selected fruits were washed to remove low-density fruits. A second manual selection step was performed to remove any remaining immature and ripe fruits. The fruits were mechanically processed (Penagos, model DVC 306) to remove the exocarp and part of the mesocarp.

The moisture content of the processed fruits was determined gravimetrically at 105 °C for 24 hours (BRASIL, 2009). The moisture content of the samples was $1.565 \pm 0.065_{DB}$.

2.2 Drying

Drying was performed in a fixed-bed dryer composed of four trays at an air speed of 0.33 ms^{-1}. Square perforated bottom trays measuring 0.30 m on the sides and 0.10 m in depth were used. The surface of each tray was covered with 1200 g of sample to form a 0.015-m high layer.

Drying was performed in two steps. The first step was performed until the moisture content reached $0.428 \pm 0.010_{DB}$. In this step, drying was performed without controlling the dew point temperature (T_{dp}). The second drying step was performed until the moisture content was $0.123 \pm 0.006_{DB}$, with dew point temperature control.

The studied dry bulb temperatures (T_{db}) were 35 and 40 °C. The dew point temperatures were 2.6, 10.8 and 16.2 °C. Two more treatments were performed without dew point temperature control at two dry bulb temperatures (40 and 35 °C), for a total of 11 treatments (Table 1). Each treatment was performed with four replicates.

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Table 1 Dry bulb temperature (T_{db}), dew point temperature (T_{dp}) and relative humidity (RH) of the drying air for partial drying and drying complementation.

Treatment	First step	Second step		
	T_{db} (°C)	T_{db} (°C)	T_{dp} (°C)	RH (%)
1	40	40	2.6	10.0
2	40	40	10.8	17.5
3	40	40	16.2	25.0
4	40	35	2.6	13.1
5	40	35	10.8	23.0
6	40	35	16.2	32.7
7	35	35	2.6	13.1
8	35	35	10.8	23.0
9	35	35	16.2	32.7
10	40	40	-	-
11	35	35	-	-

Source: Author (2021).

2.3 Sensory analysis

The sensory analysis was performed by three tasters certified by the Specialty Coffee Association (SCA). The SCA sensory analysis protocol was used according to the method proposed by Lingle (2011) for the sensory evaluation of specialty coffees. In this method, the attributes are grouped into two categories: subjective and objective. The first category includes fragrance/aroma, flavor, acidity, body, balance, aftertaste and overall impression, which are scored according to quality on a scale ranging from 6 to 10 points, with 0.25-point intervals. The second category is represented by uniformity, sweetness and clean cup (lack of defects). These objective attributes are scored on a scale ranging from 0 to 10 points, with two points per attribute assigned per cup that is considered normal in terms of uniformity, sweetness and clean cup, with five cups per sample. The final score is obtained by adding the scores of each attribute.

The medium light roast point was used; it was visually determined by the bean color by using standardized discs (SCA/Agtron Roast Color Classification System) and corresponded to 58 and 63 points for whole and ground beans, respectively, with a tolerance of ±1 point, according to the color classification system. During roasting, factors that can affect the roasting point and the curve, such as the roasting temperature and time, were monitored every 8 to 12 minutes. All samples were roasted at least 12 hours before tasting.

For each sensory evaluation, five representative cups of coffee containing a concentration of 5 g of coffee per 100 mL of water were sampled, and one sensory analysis session took place for each treatment.

2.4 Statistical analysis

Principal component analysis (PCA) was used to determine which drying (T_{db} and T_{dp}) or quality (fragrance/aroma, flavor, acidity, body, balance aftertaste, overall impression, total score) variables discriminated among the tested drying methods. The sensory attribute data were analyzed using ANOVA and the Scott Knott media test, both at 5% significance. The softwares SISVAR® (D. F. Ferreira, 2011) and Chemoface (Nunes et al., 2012) were used.

3. Results and Discussion

The results of the sensory analysis of the samples are shown in Table 2. The treatments did not differ significantly in the fragrance/aroma, acidity, body or balance attributes according to the Scott-Knott test ($p > 0.05$). Regarding the flavor attribute, treatments 2 and 8, both of which were dried from a moisture content of 0.428_{DB} with a T_{dp} of 10.8 °C, differed significantly from the others, earning the lowest flavor scores. Flavor is the main attribute used to define coffee quality, and the flavor score accounts for the intensity, complexity and quality of the taste and aroma combination (Masi et al., 2013; SCAA, 2009). The lowest scores for the attribute aftertaste were observed for treatments 1, 2, 4 and 10, which also had higher mean water reduction rates. For the attribute overall impression, the highest score was obtained with the highest T_{dp} and, consequently, the highest drying air RH, for the T_{db} combinations of 40 °C-40 °C and 35 °C-35 °C, whereas for the T_{db} combination of 40 °C-35 °C, the highest overall impression score was obtained at the intermediate T_{dp}.

Table 2 Sensory aspects of the beverage made from coffee beans subjected to different dry bulb and dew point temperature combinations.

Treatment	$T_{db\text{-}fs\text{-}ss}$ (°C-°C)	$T_{dp\text{-}ss}$ (°C)	DT (h)	F/A	FL	AC	BD	AT	BL	OI	TOT
1	40-40	2.6	21.10	7.50 a	7.83 a	7.83 a	7.83 a	7.67 b	7.50 a	7.50 b	83.7 c
2	40-40	10.8	29.50	7.50 a	7.67 b	7.50 a	7.83 a	7.50 b	7.50 a	7.50 b	83.0 c
3	40-40	16.2	35.08	7.67 a	8.00 a	8.00 a	8.00 a	8.00 a	7.83 a	8.00 a	85.5 a
4	40-35	2.6	37.50	7.50 a	7.83 a	7.67 a	7.83 a	7.50 b	7.50 a	7.50 b	83.3 c
5	40-35	10.8	44.00	7.67 a	8.00 a	7.83 a	8.00 a	8.00 a	8.00 a	8.00 a	85.5 a
6	40-35	16.2	48.00	7.50 a	7.83 a	8.00 a	8.00 a	8.00 a	7.50 a	7.67 b	84.5 b
7	35-35	2.6	44.00	7.50 a	8.00 a	7.83 a	8.00 a	8.00 a	7.67 a	7.50 b	84.5 b
8	35-35	10.8	48.33	7.50 a	7.50 b	7.67 a	7.83 a	8.00 a	7.50 a	7.50 b	83.3 c
9	35-35	16.2	53.00	7.67 a	8.00 a	7.83 a	8.00 a	7.83 a	7.67 a	7.83 a	85.0 a
10	40-40	-	30.67	7.50 a	8.00 a	7.67 a	7.83 a	7.67 b	7.67 a	7.50 b	83.7 c
11	35-35	-	48.33	7.50 a	8.00 a	7.67 a	8.00 a	8.00 a	7.67 a	7.50 b	84.3 b
CV (%)				2.00	2.21	2.97	2.46	1.92	2.55	1.61	0.56

fs = first step; ss = second step; DT = drying time; T = treatment; F/A = fragrance/aroma; FL = flavor; AC = acidity; BD = body; AT = aftertaste; BL = balance; OI = overall impression; TOT = total score. Means followed by the same letter in the column do not differ significantly according to the Scott-Knott test ($p > 0.05$).
Source: Author (2021).

Evaluation of sensory attributes allows the identification of distinct sensory characteristics and the description of the specific nuances of fragrances and flavors in a given sample (Figueiredo et al., 2015). In general, in the present study, the coffee beverages had predominantly desirable flavors, such as caramel, chocolate, fruits and honey, with no observed pattern. There was also no pattern in the description of the attributes body and sweetness, with all treatments having dense and creamy bodies and good sweetness. Treatments 3, 5 and 9 were described as having sweet acidity and a long, sweet, pleasant and desirable aftertaste (Lingle, 2011) that differed from the other treatments. Conversely, treatment 2 was described as having an unbalanced aftertaste.

According to Borém et al. (2013), a specialty coffee, synonymous with a fine or superior quality coffee, has certain characteristics, such as persistent floral, citrus and chocolate flavors, that distinguish it from other coffees and adds value to the product. Caramel and brown sugar flavors are also observed in higher-quality coffees, indicating greater caramelization of the grain sugars at the time of roasting.

Regarding the total scores of the coffees, the highest scores in the sensory analysis were observed for treatments 3, 5 and 9 (Table 2), according to the Scott Knott test ($p < 0.05$). Intermediate scores were obtained for treatments 6, 7 and 11, whereas the lowest scores were obtained for treatments 1, 2, 4, 8 and 10. This finding can be explained by the fact that the treatments with the lowest scores also had higher mean water reduction rates, since high rates can cause disrupt the endosperm, causing loss of the selective permeability of its cell membrane system, a characteristic that has been used as an indicator of coffee quality (da Silva Taveira et al., 2014; G. H. H. de Oliveira et al., 2010; Marques et al., 2008; Taveira et al., 2012).

The decrease in the water reduction rate obtained by increasing the T_{dp} promoted an increase in the sensory quality of treatment 3 compared to treatments 1, 2 and 10, which were also subjected to a T_{db} of 40 °C-40 °C. Although all coffees are classified as specialty, coffees with a score greater than or equal to 85 are described as "excellent" and classified as "special origin" according to the SCA (2015) and have higher market value. At a T_{db} of 40 °C-35 °C, both increases and reductions in the T_{dp} caused a decrease in product quality. At a T_{db} of 35 °C-35 °C, both increases and reductions in the T_{dp} caused an increase in quality, but the increase in T_{dp} (treatment 9) resulted in an "excellent" coffee.

It was observed that higher drying temperatures after the mid-dry state were detrimental to the sensory attributes of these coffees, with the only exception being treatment 3, probably due to the lower water reduction rate observed in that treatment. Borém et al. (2008) studied the effect of bean mass temperature on sensory quality after one year of storage and reported that the increase in drying temperature was detrimental to the maintenance of the sensory quality of parchment coffee. This finding corroborates the findings of Saath et al. (2012), who found that higher temperatures during the final drying step result in greater damage to the formation of sensory precursors of coffee quality.

It was observed that in the T_{db} 40 °C-40 °C and 40 °C-35 °C combinations, higher T_{dp} promoted higher total scores (Table 2). However, this pattern was not observed for the T_{db} 35 °C-35 °C combination, for which the lowest T_{dp} (2.6 °C) resulted in a higher total score than that obtained with the intermediate T_{dp} (10.8 °C). This finding may be explained by the lower initial and final drying temperatures when compared with the other two T_{db} combinations, which reduced the negative effect of the higher water reduction rate promoted by the T_{dp} of 2.6 °C on the total score.

Among treatments with and without T_{dp} control, it was observed that treatment 11 resulted in a lower total score than treatments 3 and 5, which were subjected to a higher T_{db} combination and a shorter total drying time. Despite having the same T_{db} combination, treatment 9 resulted in a product with higher sensory quality, even though the drying process took longer. Treatments 6 and 7 were equivalent to treatment 11 in terms of sensory scores. The total score for treatment 10 was one of the lowest in the experiment, equivalent to the scores for treatments 1 and 2, although the total drying time was approximately 10 hours longer than that of treatment 1. Longer drying times, as well as higher water reduction rates, may have contributed to the lower total scores due to the higher probability of thermal damage and rupture of the cell membrane of the beans, which causes intercellular fluid leakage and decreases the final quality of the beverage (Alves et al., 2013; Saath et al., 2012; Taveira et al., 2012).

The effect of the interaction between T_{db} and T_{dp} (RH) on the total scores was investigated, and the ANOVA revealed a significant interaction effect.

Table 3 shows the mean total scores obtained at each T_{db} and T_{dp} level. Among the T_{dp} levels, the highest total scores were obtained with a the T_{dp} of 16.2 °C, which resulted in an RH similar to the that of the Matas de Minas region during harvest time. At a T_{dp} of 16.2 °C, the T_{db} combinations of 40 °C-40 °C and 35 °C-35 °C resulted in higher total scores, despite the fact that the drying time required by the former combination was 34% lower than the time required by the latter combination.

At a T_{dp} of 2.6 °C, which resulted in an RH similar to that of the Cerrado region of Minas, the T_{db} combination of 35 °C-35 °C resulted in the highest total score, but it was the most time-consuming drying treatment; in contrast, at the intermediate T_{dp} of 10.8 °C, which corresponded to the RH of southern Minas Gerais state, the T_{db} combination of 40 °C-35 °C was the most appropriate for obtaining higher total scores.

Table 3 Total scores of coffee beans subjected to different dry bulb and dew point temperature combinations.

T_{db} (°C-°C)	T_{dp} (°C)		
	2.6	10.8	16.2
40-40	83.7 Bb (21.1)	83.0 Bb (29.5)	85.5 Aa (35.1)
40-35	83.3 Bc (37.5)	85.5 Aa (44.0)	84.5 Bb (48.0)
35-35	84.5 Aa (44.0)	83.3 Bb (48.3)	85.0 Aa (53.0)
CV		0.48%	

Means followed by the same lowercase letter in the row do not differ significantly within each T_{db} level according to the Scott-Knott test ($p > 0.05$). Means followed by the same uppercase letter in the column do not differ significantly within each T_{dp} level according to the Scott-Knott test ($p>0.05$). The value in parentheses indicates the drying time in hours for each treatment.
Source: Author (2021).

Regarding the T_{db} levels, the highest total scores were obtained by the T_{db} combination of 35 °C-35 °C with a T_{dp} of 2.6 and 16.2 °C.

Isquierdo et al. (2010) studied natural coffee and observed that an increased water reduction rate, obtained by reducing the T_{dp} and, consequently, the drying air RH, has a negative effect on the quality of the beverage at a T_{db} of 40 and 35 °C. However, the same pattern was not observed in the present study because, for the T_{db} combination of 35 °C-35 °C, the quality of the coffee subjected to the higher water reduction rate was not different from that of the coffee subjected to the lower rate.

To better discriminate among the coffee samples, a multivariate analysis of the sensory attributes and the tested drying factors was performed. Multivariate PCA was performed to reduce the number of variables and discriminate among the groups.

Figure 1 shows the biplots obtained according to the dispersion of the scores, with the first principal component (PC1) explaining the highest amount of variance in the data (38.52%), followed by PC2 (15.92%), PC3 (10.41%) and PC4 (9.69%) (Table 4). The first four principal components explained 74.54% of the total variance in the data set, making it possible to observe which variables contributed most to the groups that were formed.

Table 4 Estimated coefficients used to calculate the scores for the first four principal components of the drying and sensory variables.

	PC1 (38.52%)	PC2 (15.92%)	PC3 (10.41%)	PC4 (9.69%)
T_{dbi} (°C)	-0.025498	0.62129	0.19751	0.11475
T_{dbf} (°C)	-0.091004	0.57252	0.28296	0.051219
T_{dp} (°C)	0.2805	0.040175	0.38893	-0.34738
Fragrance/aroma	0.28627	0.15518	-0.061703	-0.13333
Flavor	0.27957	0.14266	-0.55043	0.31107
Acidity	0.2341	0.15692	-0.33566	-0.61305
Body	0.24328	-0.25109	0.53591	0.035198
Aftertaste	0.38345	-0.32282	0.108	0.067712
Balance	0.30271	0.053628	0.058949	0.59966
Overall impression	0.41172	0.20981	0.045461	-0.080684
Total	0.47969	0.037295	-0.076157	0.035253

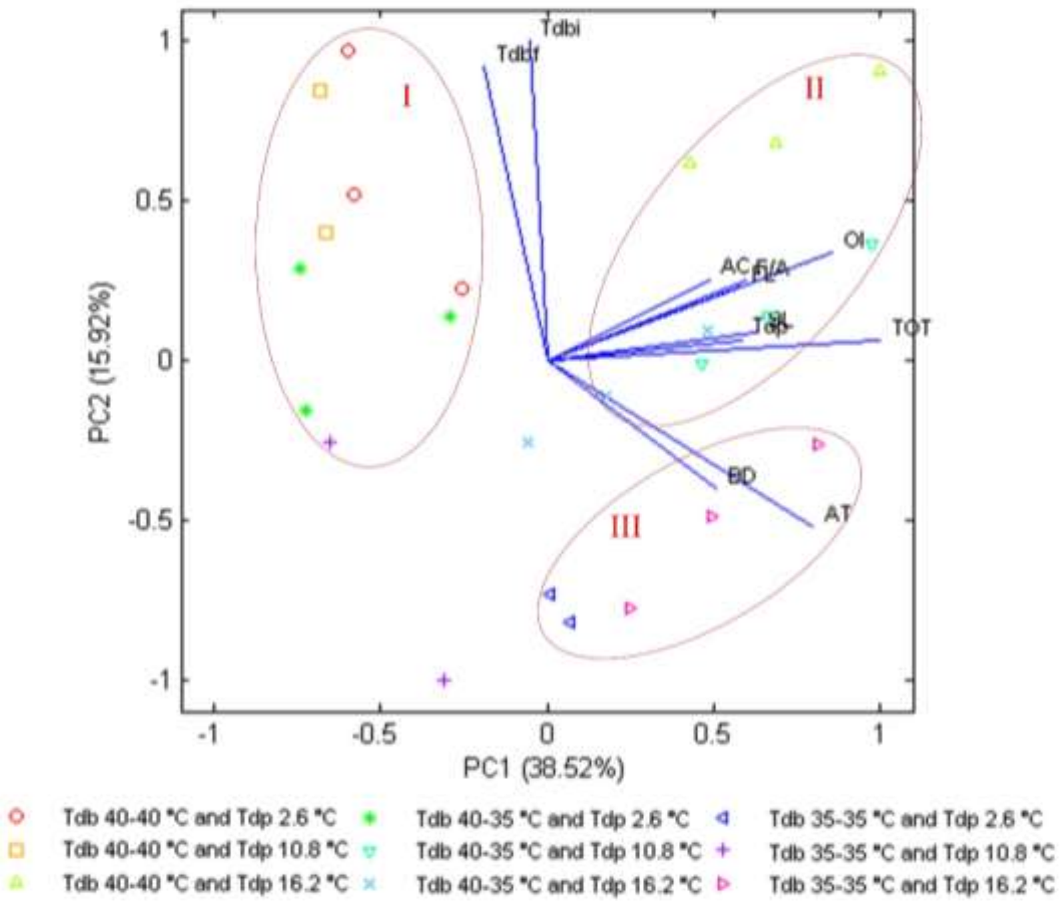
PC = principal component.
Source: Author (2021).

The angle formed by the vectors corresponds to the correlation between the studied variables (Figure 1). The smaller the angle between the vectors is, the greater the correlation between the variables. The representation of the interaction between the T_{db} and T_{dp} combinations is given by symbols. The closer one symbol is to another, the greater the similarity between the values of the studied variables.

Figure 1 shows that PC1 is positively related to all sensory attributes and to T_{dp}. The small angle formed between the vectors that represent balance, T_{dp} and total score suggests a high correlation between these variables; therefore, their scores respond similarly to the studied variables, which may be related to the fact that the highest T_{dp} results in lower drying rates, which contribute to greater cell membrane uniformity and, consequently, greater conservation of sensory quality. The same pattern is observed between the acidity, fragrance/aroma, flavor and overall impression vectors, between the body and aftertaste vectors and between the first-step T_{db} and the second-step T_{db} vectors. The angle formed between the flavor and total score vectors shows that these variables are also correlated, which can be explained by the fact that flavor is the main criterion used to evaluate quality, as it accounts for the complexity of the beverage (Masi et al., 2013), and complexity is an important characteristic of coffees recognized for their superior quality.

The first two principal components suggest similarity between the points, forming three distinct groups for the interaction between the T_{db} and T_{dp} of the drying air: the first group (I) contains the points located in the upper left quadrant of the biplot (treatments 1, 2 and 4), the second (II) contains the points located mainly in the upper right quadrant of the biplot (treatments 3, 5 and 6), and the third (III) contains the points located mainly in the lower right quadrant of the biplot (treatments 7 and 9) (Figure 1). Group I corresponds to the treatments that obtained the lowest sensory scores and were the best discriminated by the T_{db} combinations. Group II was more discriminated by the attributes balance, acidity, fragrance/aroma, flavor and overall impression and by T_{dp}; this group obtained the highest sensory scores. Group III, despite having good sensory scores, was exposed to the combinations with the lowest T_{db} (35 °C-35 °C) and was more discriminated by the body and aftertaste variables.

Figure 1 Biplots for the first two principal components of the four used to discriminate the drying types in relation to the sensory and drying variables. F/A = fragrance/aroma; FL = flavor; AC = acidity; BD = body; AT = aftertaste; BL = balance; OI = overall impression; TOT = total score; T_{dp} = dew point temperature; T_{dbi} = dry bulb temperature for the first step; T_{dbf} = dry bulb temperature for the second step.



Source: Author (2021).

Table 4 shows the weights of the sensory attributes and drying variables on the first four principal components of the samples subjected to different combinations of T_{db} and T_{dp}.

The results shown in Table 4 indicate that the variables whose contributions were most important for the formation of PC1 were the overall impression and total score attributes. Regarding PC2, the drying variables, initial and final T_{db}, were the variables that most influenced its formation. According to the correlation between the parameters, T_{dp} was explained by PC3 and PC4.

Figure 1 shows that the discrimination of groups I and II from group III was mainly due to PC2, which was formed mainly by T_{db} combinations and the overall impression attribute.

4. Conclusion

Coffee quality was influenced by the drying conditions. The principal component analysis helped to discriminate the samples. Drying at a dry bulb temperature of 40 °C and a dew point temperature of 16.2 °C (25% RH) produced higher quality coffees in less time.

Other methods and drying conditions can be studied, evaluating the influence on the sensory quality of the beverage.

Furthermore, other studies can be carried out using coffee of other varieties.

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