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PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF *Coffea canephora* Pierre Ex Froehner SUBMITED TO DIFFERENT DRYING METHODS

CARACTERÍSTICA FÍSICO-QUÍMICA E SENSORIAL DO Coffea canephora Pierre ex Froehner SUBMETIDO À DIFERENTES MÉTODOS DE SECAGEM

CARACTERÍSTICAS FISICOQUÍMICAS Y SENSORIALES DE Coffea canephora Pierre Ex Froehner SOMETIDO A DIFERENTES MÉTODOS DE SECADO

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ABSTRACT

The quality of conilon coffee can be influenced by crop management and post-harvest processing. Thus, the objective of this work was to evaluate the quality of pulped and natural conilon coffee subjected to drying methods in electric hybrid solar-electric dryer (HSED), on a patio drying (PD), and suspended patio drying (SPD). The water content, specific mass, pH, electrical conductivity, titratable total acidity and total soluble solids and sensory analysis. The physical-chemical characterization presented variations in the different types of coffee (natural and pulped) and in the drying time (before and after). However, drying in the HSED, PD, and SPD maintained the physicochemical characteristics of the desirable coffee beans for sale to the final consumer. From the results it was possible to conclude that the SHSE can be an alternative to the systems conventional drying, mainly by reducing the drying time.

Keywords: Conilon, solar energy, fine coffee.

RESUMO

A qualidade do café conilon pode ser influenciada pelo manejo da cultura e processamento pós-colheita. Assim, objetivou-se com o trabalho avaliar a qualidade do café conilon despolpado e natural submetido aos métodos de secagem em secador híbrido solar elétrico (SHSE), terreiro de chão (TC) e terreiro suspenso (TS). Avaliou-se o teor de água, massa específica, pH, condutividade elétrica, acidez total titulável e sólidos solúveis totais e análise sensorial. A caracterização físico-química apresentou variações nos diferentes tipo de café (natural e despolpado) e no tempo de secagem (antes e depois). No entanto, a secagem no SHSE, TC e TS mantiveram características físico-químicas dos grãos de café desejáveis a comercialização para o consumidor final. Pelos resultados foi possível concluir que o SHSE pode ser uma alternativa aos sistemas de secagem convencional, principalmente pela redução do tempo de secagem.

Palavras-chave: *Conilon, energia solar, café fino.*

RESUMEN

La calidad del café conilon puede verse influenciada por el manejo del cultivo y el procesamiento posterior a la cosecha. Así, el objetivo de este trabajo fue evaluar la calidad del café conilon despulpado y natural sometido a métodos de secado en secador híbrido solar eléctrico (SHSE), patio en tierra (TC) y patio suspendido (TS). Se evaluó el contenido de agua, masa específica, pH, conductividad eléctrica, acidez titulable total y sólidos solubles totales y análisis sensorial. La caracterización físico-química presentó variaciones en los diferentes tipos de café (natural y despulpado) y en el tiempo de secado (antes y después). Sin embargo, el secado en SHSE, TC y TS mantuvo las características fisicoquímicas de los granos de café deseables para la venta al consumidor final. Con base en los resultados, se pudo concluir que SHSE puede ser una alternativa a los sistemas de secado convencionales, principalmente por la reducción del tiempo de secado.

Descriptores: *Conilon, energia solar, café fino.*

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INTRODUCTION

In 2022, Brazilian coffee was sold internationally to 145 countries, with the United States and Germany being the main destinations, reaching the highest monetary value ever recorded in the historical series of the product, corresponding to an increase of 45% compared to the value observed in 2021 (CONAB, 2023). According to the 1st Coffee Crop Survey for 2023, released by the National Supply Company (Conab), the first estimate for the coffee crop points to a production of 54.94 million bags of processed coffee (CONAB, 2023).

Coffea arabica (Arabica coffee) and *Coffea canephora* (Robusta or Conilon coffee) are the species grown on a large scale in the Brazilian coffee regions. The southern and central-west regions of Minas Gerais are the largest producers of Arabica coffee in the country, while Espírito Santo has the largest production of Conilon coffee (CONAB, 2023).

In relation to Robusta or Conilon coffee, due to its higher caffeine content, it produces beans with more bitter flavors and higher levels of soluble substances, being widely used by the industry in blends and for instant coffee production. On the other hand, Arabica coffee has higher commercial values than Robusta due to its better quality. It also has intense aroma, various flavors, with numerous variations of body and acidity (PINTO et al., 2019).

The quality of coffee beans can be influenced by production conditions, as well as post-harvest operations, fruit selection, processing, drying, and storage conditions (CLEMENTE et al., 2015).

Coffee fruits are harvested with a high moisture content and, therefore, subject to conditions that favor rapid deterioration. After harvesting, coffee can be processed by the wet and dry methods, resulting in pulped and natural coffees, respectively. In choosing the best method, the location, climate of the region, availability of technology and machinery, and consumer market should be taken into consideration in order not to compromise its final quality (PEREIRA et al., 2020).

Therefore, before being stored, coffee must necessarily be dried to an ideal moisture content for storage. This step is considered of great relevance in post-harvest, both from the point of view of processing costs formation and from the point of view of quality preservation. During drying, the moisture content is reduced, eliminating risks of fermentation and development of fungi and bacteria (CLEMENTE et al. 2015; BORÉM et al., 2008).

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On the other hand, if adequate drying techniques are not used correctly, the quality may be impaired due to undesirable physical, chemical, and sensory alterations. Given these problems, greater control of drying parameters (temperature, relative humidity, air flow, and grain mass temperature) is sought to minimize adverse situations for the product.

In Brazil, basically two methods are used for drying coffee: patio drying and mechanical dryers. In patio drying, the product is spread on the floor (concrete, brick, beaten earth or asphalt) to be directly exposed to solar radiation. The beans are continuously turned with the aid of a rake or other similar equipment for product homogenization. In mechanical dryers, heated air passes through the grain mass through a forced ventilation system.

Patio drying is a method that uses only solar energy, a clean and renewable source of energy that does not entail extra costs for the producer. The use of this method in opposition to systems that use electricity or other sources of thermal energy generation such as wood or fossil fuels is justified by the increase in production costs and environmental and human health impacts (MOREIRA et al., 2019). However, this method exposes the product to biological agents (insects and animals), dirt and foreign materials, and unfavorable climatic conditions, as well as requiring more drying time for the product to reach the desired moisture content, which may compromise the final grain quality (NAKAYAMA et al., 2020).

One option to overcome these problems is the use of indirect solar dryers composed of a drying chamber and a solar collector. Solar radiation hits the solar collector, converting solar energy into thermal energy for heating the ambient air. The existence of the drying chamber provides increased drying efficiency due to the greenhouse effect and keeps the products protected from external agents that may compromise the final product quality. Furthermore, hybrid dryers are used, which involve the combination of solar dryers with other sources of energy that help to keep the drying system functioning during the absence of solar radiation (PAES et al., 2020; VARGAS et al., 2020; JHA & TRIPATHY, 2021).

The use of new technologies and research in the area seeks to increasingly investigate quality parameters in order to produce a beverage with remarkable properties that please consumers' taste.

Thus, the objective was to characterize the final quality of coffee processed by dry and wet methods, subjected to different drying methods.

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MATERIALS AND METHODS

The experiment was conducted at the Multi-User Research Laboratory of the Rural Renewable and Alternative Energy Group (LabGERAR) of the Rural Federal University of Rio de Janeiro (UFRRJ), located in Seropédica - RJ, Brazil, with geographical coordinates of 22º 45' 33" S and 43º 41' 51" W. The climate of the region is classified as Aw according to the Köppen classification system, with an average annual temperature of 24.5 ºC.

Organic coffee fruits of the Emcapa 8121 cultivar were manually harvested, with an initial moisture content of 1.64 dry basis (d.b.) at Fazendinha Agroecológica km 49 located in the municipality of Seropédica, State of Rio de Janeiro, Brazil. Then, a cleaning process was carried out to remove leaves, pieces of branches, foreign materials, and immature, deteriorated, or damaged fruits to obtain a homogeneous material.

After the selection process, batches of coffee were separated to be processed by dry and wet methods to obtain natural and pulped coffees, respectively.

The pulping of the fruits was carried out manually with immersion of the coffee beans in water for 24 hours to remove the mucilage. After the preparation and separation of the batches, the coffee fruits were taken to the drying process. Drying occurred in the hybrid solar-electric dryer (HSED), on a patio drying (PD), and suspended patio drying (SPD).

The hybrid solar-electric dryer (Figure 1) has a drying chamber, solar collector (photothermal energy), photovoltaic system (electric energy) with a solar tracker, and an exhaust fan, as described by Paes et al. (2020).

Figure 1 - Hybrid solar-electric dryer (HSED)

Source: GERAR

The drying chamber has the capacity for three shelves, each containing nine small removable baskets to facilitate the weighing of samples. The baskets have a mesh bottom to allow the drying air to pass through the sample. Each basket was filled with a thin layer of 0.03 m of natural or pulped conilon coffee fruits. Inside the hybrid solar-electric dryer, the average temperature and relative humidity of the drying air were 33 and 63%, respectively (PAES et al., 2020).

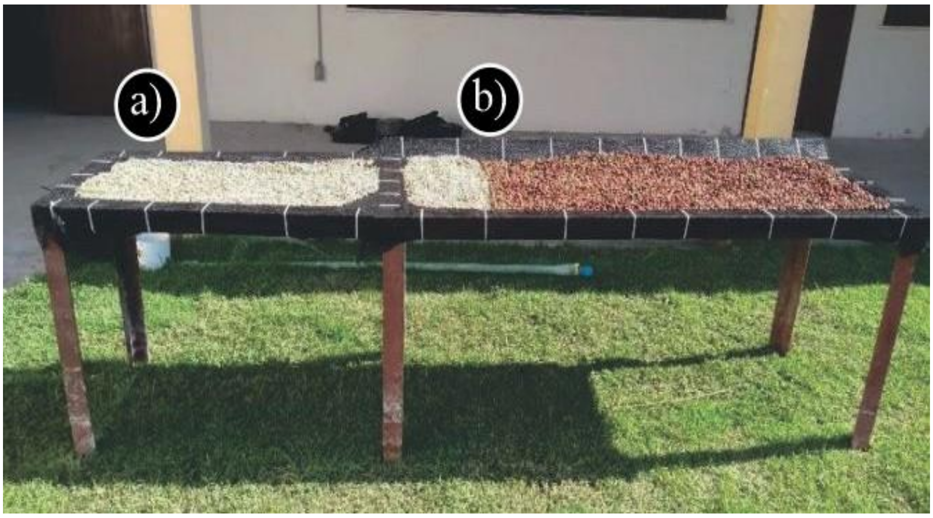
Lots of natural and pulped conilon coffee were separated into 1.0 m² cells for drying, characterizing artificial drying on a patio drying (Figure 2).

Figure 2 - Drying of Conilon coffee on a patio drying a) natural and b) pulped

Source: GERAR

The suspended patio drying system was made up of a 70% shade cloth and a steel frame with dimensions of 0.60 x 2.70 x 0.80 m (width x length x height) (Figure 3).

Figure 3 - Suspended patio drying of Conilon coffee a) pulped and b) natural



Source: GERAR

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The shade cloth was fixed onto the rectangular frame in a way that it could sustain its own weight and that of the sample, allowing for better utilization of its surface area and preventing the accumulation of samples in specific areas.

Daily, the product was spread in layers of 0.03 m thickness on the surface of the cloth. During the day, regular turning was carried out every hour. The drying of Conilon coffee beans occurred at ambient temperature, ambient relative humidity, and solar radiation with average values of 27.6 ºC, 68.4%, and 306.9 W m^{-2}, respectively (PAES et al., 2020).

The drying methods using the hybrid solar-electric dryer, patio drying, and suspended patio drying occurred from 7:00 a.m. to 5:00 p.m. The period between 5:00 p.m. and 7:00 a.m. was considered a 14-hour intermittent period. During this time, to prevent external interference in the internal microclimate, in HSED the exhaust system was closed, the solar collector and drying chamber were sealed, and the samples in the PD, and SPD drying were covered with a black tarp. The total drying time for the analyzed methods was determined when the grain samples reached a minimum average moisture content of 0.08 b.s.

Physical-chemical analyses were carried out before and after drying for each coffee batch (natural and pulped) and from the three drying methods (HSED, PD, and SPD). The analyses included moisture content (MC) (BRASIL, 2009), bulk density (BD) (IAL, 2008), hydrogen potential (pH) (IAL, 2008), electrical conductivity (EC) (KRZYZANOWSKI et al., 1991), total soluble solids (TSS) (IAL, 2008), and total titratable acidity (TTA) (IAL, 2008), in triplicate.

After the drying process, the quality of the coffee batches obtained was verified through sensory analysis. The form of the Coffee Quality Institute (CQI) was adopted for the tasting of fine Conilon coffee. The sensory analysis was carried out by three Certified Cupping Judges.

For the comparison of physical and chemical characteristics due to the drying methods (HSED, PD, and SPD) before and after drying, a completely randomized design in a 2 x 2 factorial scheme was adopted, where the treatments consisted of two types of coffee (natural and pulped) and two evaluation periods (before and after drying). For the comparison between the drying systems, a completely randomized design in a 2 x 3 factorial scheme was adopted, where the treatments were two types of coffee (natural and pulped) and three drying methods (HSED, PD, and SPD). The obtained results, in both types of designs, were subjected to analysis of variance, and the mean data were compared by the Tukey test at 5% probability using the statistical program SISVAR, version 5.6.

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RESULTS AND DISCUSSION

As expected, the moisture content of the natural and pulped coffee after drying presented statistically lower values (Table 1). However, after drying, the pulped coffee (0.08 b.s.) did not differ statistically from the natural coffee (0.10 b.s.). Both presented average values below 0.13 b.s., which is recommended for the storage of conilon coffee (FERRÃO et al., 2007).

For bulk density, the values found between 100.00 and 157.33 kg m^{-3} were lower than those presented in the literature, such as 391.3 and 616.6 kg m^{-3} (COUTO et al., 1999), 389.7 and 609.9 kg m^{-3} (SILVA et al., 2006), and 311.2 and 406.8 kg m^{-3} (OLIVEIRA et al., 2014). It was observed that after drying, the values were statistically lower when compared to the results before drying. According to Botelho (2016), bulk density decreases after drying, as it follows the reduction in moisture content, as observed in this experiment.

The pH of natural coffee and after drying in HSED (Table 1) was statistically lower (5.16) than the other treatments. According to Subtil (2017), pH lower than 5.36 can negatively affect the quality of the bean, causing fermentation and greater acidity.

Electrical conductivity data was possible to observe that natural coffee presented statistically lower values than pulped coffee. According to Resende et al. (2011), lower electrical conductivity values are associated with higher quality coffees.

Natural coffee presented higher total soluble solids values compared to pulped coffee, regardless of the drying time (Table 1). Subtil et al. (2017) found total soluble solids values ranging from 4.33 to 5.90 ^{o}Brix for Conilon coffee samples obtained from a quality contest. According to the authors, higher values are desirable due to their contribution to ensuring a fuller-bodied drink.

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Table 1 - Mean values of moisture content (MC), bulk density (BD), pH, electrical conductivity (EC), total soluble solids (TSS), and total titratable acidity (TTA) of natural and pulped coffee, before and after drying in hybrid solar-electric dryer (HSED)

Parameters	Period	Natural	Pulped	Mean
MC (decimal b.s.)	Before	1.64Aa	0.83Ba	1.23
	After	0.10Ab	0.08Ab	0.09
	Mean	0.87	0.45	
BD ($kg\ m^{-3}$)	Before	138.50Ba	157.33Aa	147.92
	After	106.17Ab	100.00Ab	103.09
	Mean	122.34	128.67	
pH	Before	7.59Aa	7.49Aa	7.54
	After	5.16Bb	7.21Aa	6.19
	Mean	6.38	7.35	
EC ($\mu S\ (cm\ g)^{-1}$)	Before	3.51Aa	2.79Ba	3.15
	After	4.96Aa	1.97Bb	3.47
	Mean	4.24	2.38	
TSS ($^{o}Brix$)	Before	7.97Aa	4.90Bb	6.44
	After	9.30Aa	4.83Ba	7.07
	Mean	8.64A	4.87B	
TTA ($mL_{NaOH}\ g^{-1}$)	Before	4.67Ab	6.70Aa	5.69
	After	28.81Aa	8.27Ba	18.54
	Mean	16.74	7.49	

* Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ from each other by the Tukey 5% probability test.

The total titratable acidity (Table 1) was well below those observed in the literature. For natural coffee after drying, the mean value was higher (28.81 $mL_{NaOH}\ g^{-1}$) than the other treatments. High acidity harms coffee quality, as they are associated with fermentation and/or degradation (BÓREM et al., 2008). Peisino et al. (2015), working with specialty coffees, observed total titratable acidity ranging from 176.66 to 229.79 $mL_{NaOH}\ g^{-1}$ of sample.

In Table 2, it was observed that the mean values of the physicochemical parameters of drying in PD presented the same behavior observed for drying in HSED.

The same occurred for HSED and PD, showing that bulk density accompanies the reduction in moisture content both in natural and pulped coffee. According to Couto et al. (1999), the apparent bulk density decreases with the decrease in moisture content of coffee beans, indicating that as the moisture of a sample of beans is reduced, its mass decreases more quickly than its volume.

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According to the authors, coffee beans behave differently in terms of apparent bulk density than most agricultural grains, whose apparent bulk density decreases with increasing moisture content of the product.

Table 2 - Mean values of moisture content (MC), bulk density (BD), pH, electrical conductivity (EC), total soluble solids (TSS), and total titratable acidity (TTA) of natural and pulped coffee, before and after drying on a patio drying (PD)

Parameters	Period	Natural	Pulped	Mean
MC (decimal b.s.)	Before	1.64Aa	0.83Ba	1.23
	After	0.10Ab	0.09Ab	0.09
	Mean	0.87	0.46	
BD ($kg\ m^{-3}$)	Before	138.50Ba	157.33Aa	147.91
	After	106.00Ab	103.67Ab	104.84
	Mean	122.25	130.50	
pH	Before	7.59Aa	7.49Aa	7.54
	After	5.44Bb	7.27Aa	6.36
	Mean	6.52	7.38	
EC ($\mu S\ (cm\ g)^{-1}$)	Before	3.51Aa	2.79Ba	3.15
	After	4.91Aa	2.21Bb	3.56
	Mean	4.21	2.50	
TSS (^{o}Brix)	Before	7.97Ba	4.90Aa	6.44
	After	8.23Ba	4.57Ab	6.40
	Mean	8.10A	4.74B	
TTA ($mL_{NaOH}\ g^{-1}$)	Before	4.67Ab	6.70Aa	5.69
	After	23.47Aa	6.13Ba	14.80
	Mean	14.07	6.42	

* Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ from each other by the Tukey 5% probability test.

According to Table 3, the pH decreased after drying regardless of coffee type, yet the values found after drying (mean of 5.93) are considered high. Angelim et al. (2021), the acceptable pH of coffee should be around 5.0.

Electrical conductivity, regardless of drying time, presented an average of 268.60 $\mu S\ (cm\ g)^{-1}$ for pulped coffee, which is higher when compared to natural coffee (4.45 $\mu S\ (cm\ g)^{-1}$) (Table 3). In the literature, the electrical conductivity values for coffee beans are around 37.02 and 122.08 $\mu S\ (cm\ g)^{-1}$ (NOIA, 2017), 86.00 and 202.30 $\mu S\ (cm\ g)^{-1}$ (PINHEIRO, 2012). Electrical conductivity is related to the release of electrolytes in the solution and, to some extent, can influence the quality of the final product.

For total soluble solids and total titratable acidity of the coffees dried in SPD (Table 3), the same behavior was observed as for the coffees dried in HSED (Table 1) and PD (Table 2).

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Table 3 - Mean values of moisture content (MC), bulk density (BD), pH, electrical conductivity (EC), total soluble solids (TSS), and total titratable acidity (TTA) of natural and pulped coffee, before and after drying, on a suspended patio drying (SPD)

Parameters	Period	Natural	Pulped	Mean
MC (decimal b.s.)	Before	1.64Aa	0.83Ba	1.23
	After	0.14Ab	0.08Ab	0.09
	Mean	0.89	0.45	
BD (kg m^{-3})	Before	138.50Ba	157.33Aa	147.91
	After	108.00Ab	105.00Ab	106.50
	Mean	122.34	128.67	
pH	Before	7.59Aa	7.49Aa	7.54
	After	5.54Ba	6.32Aa	5.93
	Mean	6.57	6.91	
EC (μS $(cm\ g)^{-1}$)	Before	3.51Aa	2.79Ba	3.15
	After	5.39Aa	2.58Bb	3.98
	Mean	4.45	2.38	
TSS (^{o}Brix)	Before	7.97Aa	4.90Bb	6.44
	After	9.53Aa	3.33Ba	6.43
	Mean	8.75	4.12	
TTA ($mL_{NaOH}\ g^{-1}$)	Before	4.67Ab	6.70Aa	5.69
	After	22.29Aa	5.59Ba	13.94
	Mean	13.48	6.15	

* Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ from each other by the Tukey 5% probability test.

Table 4 presents the physicochemical parameters after drying under the three drying systems. An interaction was observed between coffee types and drying systems for moisture content, bulk density, pH, and electrical conductivity. For total soluble solids and total titratable acidity, significant differences were only found for coffee types, regardless of the drying system.

Regarding moisture content, it was possible to observe that natural coffee, dried in SPD, presented a moisture content of 0.14 decimal b.s., which is the highest value found after drying. However, according to Ferrão et al. (2007), this value is above the recommended limit for safe coffee storage.

In terms of drying method, it was found that the drying time for HSED was 6 days, while for PD and SPD it was 12 days. Thus, with HSED it was possible to obtain a moisture content within acceptable limits for storage and commercialization with a drying time 50% shorter than conventional methods.

Furthermore, for all types of drying, the moisture content values for natural coffee were statistically higher than for pulped coffee. The presence of the skin and parchment surrounding the natural bean contributes to a high moisture content, as it affects the grain's hygroscopic equilibrium (AFONSO JUNIOR, 2001), which may explain the higher moisture content in natural coffee and lower in pulped coffee.

It is important to note that the coffee dried with HSED reached a moisture content of approximately 0.09 decimal b.s. in six days. During this period, the natural coffees had a moisture content of 0.23 and 0.20 decimal b.s. for SPD and PD, respectively. For pulped coffees, the values were 0.17 and 0.15 decimal b.s. for SPD and PD. In the PD and SPD drying methods, the coffee only reached the appropriate moisture content after twelve days of drying. This shows that the drying time with HSED was drastically reduced compared to the time required using conventional drying methods (SPD and PD). These results show that HSED is efficient in drying conilon coffee, as observed by Paes et al. (2020).

In Table 4, for all drying systems, natural coffee presented higher bulk density. Vieira et al. (2001) describe that bulk density is a quality parameter adopted by classification standards for some agricultural grains, mainly by the food industry, as an indicator of processing yield and final product quality. Although it is not a consistent indicator of the quality of agricultural grains, bulk density influences the determination of the static capacity of silos required to store a certain amount of grains.

For pH, the pulped coffee presented the highest values for all types of drying when compared to natural coffee. According to Siqueira and Abreu (2006), pH is indicative of possible transformations of coffee fruits, such as undesirable fermentations that occur during pre- or post-harvest, resulting in defects. Thus, coffees with low pH may have greater bitterness and acidity. A similar behavior was observed for electrical conductivity, where natural coffee presented the lowest values for all drying systems.

For total soluble solids, regardless of the type of drying, natural coffee had an average of 9.02 ºBrix, which was higher than the pulped coffee average of 4.24 ºBrix (Table 4). According to Resende et al. (2011), the best quality for conilon coffee was observed for higher total soluble solids and lower electrical conductivity. For total titratable acidity, once again, natural coffee had higher values (24.86 mL_{NaOH} g^{-1}) regardless of drying, however, the values found are well below those found in the literature and therefore can be considered acceptable.

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Table 4 - Mean values of moisture content (MC), bulk density (BD), pH, electrical conductivity (EC), total soluble solids (TSS), and total titratable acidity (TTA) of natural and pulped coffee, before and after drying in hybrid solar-electric dryer (HSED), patio drying (PD), and suspended patio drying (SPD)

Parameters	Type de secagem	Natural	Pulped	Mean
MC (decimal b.s.)	HSED	0.10Ab	0.08Bc	0.09
	PD	0.10Ab	0.09Bb	0.09
	SPD	0.14Aa	0.10Ba	0.12
	Mean	0.11	0.09	
BD (kg m^{-3})	HSED	106.17Aa	100.00Bb	103.09
	PD	106.00Aa	103.67Ba	104.84
	SPD	108.00Aa	105.00Ba	106.50
	Mean	106.72	102.89	
pH	HSED	5.16Ba	7.21Aa	6.19
	PD	5.44Ba	7.27Aa	6.36
	SPD	5.54Ba	6.32Ab	5.93
	Mean	5.38	6.93	
EC (μS $(cm\ g)^{-1}$)	HSED	4.96Ba	1.97Ab	3.46
	PD	4.91Ba	2.21Aab	3.56
	SPD	5.39Ba	2.58Aa	3.98
	Mean	5.09	2.25	
TSS (^{o}Brix)	HSED	9.30Aa	4.83Bb	7.07
	PD	8.23Aa	4.57Bb	6.40
	SPD	9.53Aa	3.33Bb	6.43
	Mean	9.02	4.24	
TTA ($mL_{NaOH}\ g^{-1}$)	HSED	28.81Aa	8.27Ba	18.54
	PD	23.47Ab	6.13Bb	14.8
	SPD	22.29Ac	5.59Bc	13.94
	Mean	24.86	6.66	

*Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ from each other by the Tukey 5% probability test.

In the physical analysis of the coffee lots, observed similar results for the three types of drying, with a greater emphasis on the number of defects in natural coffee (Table 5).

Table 5 - Data from the physical analysis of natural and pulped coffee conilon dried in hybrid solar-electric dryer (HSED), patio drying (PD), and suspended patio drying (SPD)

	HSED	
	Natural	Pulped
Aroma	Light	Light
Flavor	Slight green bean flavor	Light and distinct
Body	Semi-full-bodied	Semi-full-bodied
Acidity	Low	Low
Bitterness	Medium	Light
Technical Opinion	Good quality coffee	Good quality coffee
	PD	
	Natural	Pulped
Aroma	Medium	Light
Flavor	Medium	Light
Body	Semi-full-bodied	Semi-full-bodied
Acidity	Low	Low
Bitterness	Medium	Light
Technical Opinion	Medium quality coffee	Good quality coffee
	SPD	
	Natural	Pulped
Aroma	Light	Light
Flavor	Slight green bean flavor	Slight conilon flavor
Body	Semi-full-bodied	Semi-full-bodied
Acidity	Low	Low
Bitterness	Light to Medium	Light
Technical Opinion	Good quality coffee	Good quality coffee

The high number of defects influenced the cupping test, where natural coffees (HSED and SPD), despite their good quality, had a slight taste of green beans (Table 6). Naturally processed coffee dried in PD, the quality of the beverage was of medium quality (Table 6).

The presence of green beans is characterized as defects (Table 5), and it alters the quality of the beverage to some extent. For the pulped coffee, the quality of the beverage was good for all types of drying. Although better quality was not observed for HSED, it is a viable alternative for drying coffee in a shorter time.

Silva et al. (2020) also obtained good quality beverage using peeled cherry and naturally processed coffee beans dried in a hybrid solar-electric dryer, demonstrating its effectiveness for coffee bean drying.

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Table 6 - Qualitative analysis data (cupping test) of natural and pulped coffee dried in hybrid solar-electric dryer (HSED), patio drying (PD), and suspended patio drying (SPD)

	HSED	
	Natural	Pulped
Type	5-25	2-30
Defects	63	9
Color	Characteristic brown	Characteristic brown
Appearance	Regular	Good
Dryness	Good	Regular
Beans	Medium/small flat beans	Medium/small flat beans
	PD	
	Natural	Pulped
Type	5-45	3
Defects	80	12
Color	Characteristic brown	Characteristic brown
Appearance	Regular	Regular
Dryness	Good	Good
Beans	Medium/small flat beans	Medium/small flat beans
	SPD	
	Natural	Pulped
Type	5-15	3-20
Defects	57	18
Color	Characteristic brown	Characteristic brown
Appearance	Regular	Regular
Dryness	Regular	Good
Beans	Medium/small flat beans	Medium/small flat beans

CONCLUSION

The physicochemical composition of conilon coffee presented acceptable variations for different types of processing and drying. Pulped coffee presented better quality beverage, according to sensory analysis, regardless of the type of drying, although drying in HSED occurred in a shorter period.

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