

Sensory evaluation and color of *Coffea arabica* coffee from the Central Mexican Highlands

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ABSTRACT

Coffee is cultivated worldwide at an average altitude of 1,500 m worldwide, but in Mexico is typically cultivated around 1,200 m. However, in Temascaltepec, Mexico State, coffee is grown at 2,100 m, resulting in a slower development process that yields a “differentiated quality.” This quality has been nationally recognized at the “Cup of Excellence” competition, where coffees scoring above ninety points out of a hundred have received the “presidential award.” This recognition has enabled these coffees to be sold as “specialty” coffee at auction to Europe and Asia, fetching higher prices per pound and thus improving economic returns. In this study, we scientifically validate these claims by evaluating sensory quality in the cup and color of the bean, for which two toasting start temperatures were used. The color in roasted coffee is derived from caramelization due to the high temperatures to which it is subjected during this process. This characteristic has an intrinsic influence for the taster even though it is not objectively measured during the cupping process. For this reason, it was decided to carry out the measurement in this research. In 2022, Arabica coffee beans of the Caturra variety were harvested from Temascaltepec using a natural process. The coffee was roasted according to the Specialty Coffee Association (SCA) protocol at five time intervals (8, 9, 10, 11, and 12 min) starting from two initial roasting temperatures (210 and 215 °C). The roasted coffee was evaluated using the sensory analysis protocol of the SCA, which assessed fragrance/aroma; flavor, aftertaste, acidity, body, and balance; sweetness, uniformity, and cleanliness. In addition, we quantified the color of the coffee bean using a colorimeter. Sensory evaluation indicated that the best treatment was 215 °C/10min, with a predominant vanilla aroma (balsamic-sweet aromatic family) and an L* value of 13, suggesting a medium roast that may retain its functional properties. All treatments yielded values within proposed standards for a medium roast.

Key words: Aroma; specialty coffee; flavor; Hunder lab.

1 INTRODUCTION

Coffee is the world’s most popular beverage after water, prized for its flavor, aroma, and stimulant effects (Gruczyńska et al., 2018). Beyond its sensory appeal, coffee also offers nutraceutical properties, containing phenolic compounds that have been associated with optimizing health and reducing the incidence of cardiovascular disease (Schroeter et al., 2006; Perez et al., 2009). Notably, caffeine, which is contained in coffee, is a natural stimulant and is the most widely consumed and socially accepted stimulant substance globally (Pardo et al., 2007).

There are two important coffee varieties—Robusta and Arabica—with Vietnam leading in Robusta production and Brazil in Arabica. Mexico ranks tenth in global coffee production, with the states of Chiapas, Veracruz, and Oaxaca accounting for 72.42% of the national output, while other states contribute the remaining 27.58%, including the State of Mexico (SIAP, 2022). Despite its marginal contribution, coffee from the State of Mexico has gained recognition for its high quality in the Cup of Excellence competition, allowing it to be auctioned to international specialty coffee importers and roasters through electronic auctions (SIAP, 2022; Munguía; Munguía; Cárdenas, 2023).

The exceptional quality of coffee from this region has garnered attention since 2018, achieving high rankings in the Cup of Excellence competition and receiving prestigious awards. However, limited information is available regarding the processing of coffee in this region. Previous studies have indicated that coffee drying methods vary, including African beds and rooftop drying in municipalities such as Amatepec, Sultepec, and Temascaltepec (Leguizamo et al., 2023a, b).

Green coffee contains thousands of chemicals responsible for its flavor and aroma, driving researchers to identify key chemicals produced during roasting (Holscher; Vitzthum; Steinhart, 1990). Drying is a crucial part of coffee processing, as it impacts the quality of the roast (Yang et al., 2016). The roasting process involves complex thermal and chemical changes that affect the quality and price of the final beverage. Sensory attributes such as bitterness, astringency, burnt notes, and nutty aromas are closely tied to the type and degree of roasting (Giacalone et al., 2019).

Roasted and ground coffee is available in various colors (roast degrees), ranging from light to dark, which is controlled by roast time and temperature and measured qualitatively and quantitatively (Somporn et al., 2011; Farah, 2012). The color in roasted coffee is derived from caramelization due

to the high temperatures to which it is subjected during this process. This characteristic has an intrinsic influence for the taster even though it is not objectively measured during the cupping process. For this reason, it was decided to carry out the measurement in this research. Color changes result from reactions induced by high temperatures within the bean, such as caramelization and the Maillard reaction (Sunarharum; Williams; Smyth, 2014).

Sensory quality is the most important parameter driving coffee price and consumer preference (Stone; Bleibaum; Thomas, 2020). Sensory evaluation involves cupping, where coffee is tasted under specific conditions, evaluating acidity, aroma, flavor, and body on a scale of 0 to 10, with balanced intensity yielding the highest quality (Gutiérrez; Barrera, 2015). This study aims to determine the influence of initial temperature roasting on the aromatic development of coffee (Caturra Red) from the State of Mexico.

2 MATERIAL AND METHODS

For the drying process, we selected coffee with 55% moisture content of the Arabica variety Caturra Red harvested in 2021 and 2022. In Toluca, Mexico State (100°02' W longitude and 19°03' N latitude), the beans were dried outdoors on African beds made of wood and galvanized mesh, positioned one meter above the ground to allow for aeration. The beds were exposed to the elements until reaching 10% moisture content (three replicates were considered). Once the material was dehydrated and ready for roasting, 10 treatments were generated (210 °C for 8, 9, 10, 11, and 12 minutes and 215 °C for 8, 9, 10, 11, and 12 minutes), each with three replicates. Sensory analysis was performed by three tasters (one for each replicate) on all 10 roasting treatments. The color of the beans was determined using a Konica Minolta CR-410 colorimeter (Hunder Lab, Reston, VA) on a subsample of 5 g of ground beans, measuring the colorimetric coordinates L^* , a^* , and b^* in the CIELab system.

For sensory analysis, three SCA-certified Q grader tasters followed the protocol detailed by the SCA (Specialty Coffee Association - SCA, 2024), using the SCA Arabica cupping form (reproduced in Figure 1) to score fragrance/aroma, flavor, aftertaste, acidity, body, and balance, sweetness, uniformity, and cleanliness. The protocol is described in SCA (2024), but briefly, the evaluation consisted of the following steps:

First, the recommended quantity of beans (5.5–60.1 g of coffee per 100 mL of water) was ground, divided into three samples, and covered. Fragrance was then assessed within 15 minutes by smelling the dry ground beans. The dry coffee was then infused with water at approximately 93°C, leaving the crust (top layer of solids) intact for 3–5 minutes, followed by cupping and aroma assessment by smelling the cupped beverage.

Flavor and aftertaste were assessed when the coffee had cooled to approximately 71 °C, 8–10 minutes after infusion, when retro-nasal vapors are at their peak intensity. The flavor score includes the intensity, quality, and complexity of the combination of flavor, while aftertaste scores increase with increased duration of positive flavor attributes (flavor and aroma) and decrease when the aftertaste has a short duration or is unpleasant.

Acidity, body, and balance were assessed when the coffee had cooled to 160 °F – 140 °F (71 °C–60 °C). Balance refers to the taster's judgment of how well the aftertaste, acidity, and body interact synergistically. Tasters evaluated the different characteristics at various temperatures (two or three times) according to their preference and noted any changes if the sample gained or lost perceived quality while cooling.

Sweetness, uniformity, and cleanliness were evaluated when the coffee reached less than 37 °C. For these qualities, the taster rated each of five cups individually, awarding two points per cup per deserving quality

Specialty Coffee Association Arabica Cupping Form

Name: _____

Date: _____

Table no: _____

Quality Scale			
6.00 - GOOD	7.00 - VERY GOOD	8.00 - EXCELLENT	9.00 - OUTSTANDING
6.25	7.25	8.25	9.25
6.50	7.50	8.50	9.50
6.75	7.75	8.75	9.75

Sample No.	Roast Level of Sample	Fragrance/Aroma	Flavor	Acidity	Body	Uniformity	Clean Cup	Overall	Total Score
		Score: _____	Score: _____	Score: _____	Score: _____	Score: _____	Score: _____	Score: _____	
		Qualities: _____	Aftertaste: _____	Intensity: _____	Level: _____	Balance: _____	Sweetness: _____	Defects (subtract): _____	
		Break: _____	Intensity: _____	High: _____	Heavy: _____			Taint - 2: _____	
			Low: _____	Thin: _____				Fault - 4: _____	
Notes: _____									Final Score: _____

Figure 1: Sensory Evaluation Form of the SCA.

3 RESULTS

(maximum of 10 points). Beverage evaluation concluded when the sample reached 21 °C. The protocol includes deductions of two points per cup for “contaminations” (mild off-flavor typically found in aromatic aspects) or four points per cup for faults (pronounced off-flavor, often found in “taste” aspects) which are subtracted from the total score and described qualitatively; however, this was not the case for any of the cups tasted in this study. The overall score ranges over a 100-point scale with clearly defined ranges (see Table 1).

Table 1: Score, Specialty Grade Description, and Classification.

Total Score	Description of Specialty	Classification
90-100	Exceptional	Rare Specialty
85-89.99	Excellent	Special Origin
80-84.99	Very Good	Specialty
70–79.9	Below Specialty Quality	Commercial/Basic grade
<69.9	Below Specialty Quality	Defective

2.1 Experimental design

For the roasting process, a completely randomized design was used, establishing ten treatments consisting of five roasting durations (8, 9, 10, 11, and 12 min) at each of two roasting temperatures (210 °C and 215 °C). For all results, an ANOVA ($p \leq 0.05$) was performed, and when significant differences ($p \leq 0.05$) were detected among treatments, a Tukey’s HSD test was applied for mean comparison. The response variables for sensory analysis were fragrance/aroma; flavor, aftertaste, acidity, body and balance; sweetness, uniformity, and cleanliness (described above), and for color were L^* , a^* , b^* . the latter was performed the Bonferroni test.

Table 2: Coffee Color.

Temperature (°C)	Time (min)	L^*	a^*	b^*	CHROMA	Hue
210	8	13.3±0.001d	24.6±0.001e	22.9±0.001d	47.6±0.001d	0.8±0.001e
	9	15.1±0.001f	23.8±0.001b	26.0±0.001f	49.8±0.001e	0.7±0.001b
	10	16.0±0.001g	24.8±0.001f	27.6±0.001g	52.5±0.001f	0.7±0.001b
	11	13.1±0.001c	24.0±0.001c	22.5±0.001c	46.6±0.001b	0.8±0.001e
	12	10.8±0.001a	24.9±0.001f	18.7±0.001a	43.7±0.001a	0.9±0.001h
215	8	16.7±0.001h	23.6±0.001a	28.7±0.001h	52.3±0.001d	0.6±0.001a
	9	14.8±0.001f	24.4±0.001d	25.5±0.001f	49.9±0.001e	0.7±0.001c
	10	13.9±0.001e	24.0±0.001c	23.9±0.001e	47.9±0.001f	0.7±0.001c
	11	12.8±0.001b	24.6±0.001e	22.0±0.001b	46.6±0.001b	0.8±0.001g
	12	13.1±0.001c	24.5±0.001e	22.6±0.001c	47.2±0.001c	0.8±0.001f

Note 1: Within each column, different letters (a, b, c, d, e, f, g, and h) indicate significant differences among treatments. L^* ranges from 0 to 100 indicating luminance (black/white), a^* ranges from -60 (green) to 60 (red), and b^* ranges from -60 (yellow) to 60 (blue). Chroma = square root ($a^{*2} + b^{*2}$) and Hue = inverse tangent (a^*/b^*).

3.1 Coffee Color Table 2 presents the color results (mean $\pm$ SD of L^* , a^* , and b^*) of the roasted coffee for each treatment in the roasting experiment (temperature and time).

Note 1: Within each column, different letters (a, b, c, d, e, f, g, and h) indicate significant differences among treatments. L^* ranges from 0 to 100 indicating luminance (black/white), a^* ranges from -60 (green) to 60 (red), and b^* ranges from -60 (yellow) to 60 (blue).

3.2 Sensory Analysis

Table 3 presents the average results of the evaluation of sensory attributes for each of the 10 treatments assessed by three Q grader tasters.

4 DISCUSSION

4.1 Color

The discussion of color in this study aligns with previous research. Salazar et al. (2020) conducted an experiment on the evaluation of chemical compounds in the Típica variety of *Coffea arabica* during the artisanal grinding and roasting process. They classified roasting as light when L^* values were 29.57, a^* 26.14, and b^* 29.18; medium when L^* 16.62, a^* 16.38, and b^* 16.57; and finally dark when L^* 7.86, a^* 7.44, and b^* 7.85. In this study, L^* values ranged from 10.8 to 17.7, a^* from 26.6 to 24.9, and b^* from 18.7 to 28.7, indicating a classification from light to medium. These findings are consistent with previous works, which observed that L^*

Table 3: Sensory Analysis Results.

Treatment (°C)	Time (min)	Fragrance/aroma $\bar{x} \pm DE$	Flavor $\bar{x} \pm DE$	Residual flavor Principio del formulario $\bar{x} \pm DE$	Acidity $\bar{x} \pm DE$	Body $\bar{x} \pm DE$	Uniformity $\bar{x} \pm DE$	Balance $\bar{x} \pm DE$	Sweetness $\bar{x} \pm DE$	Average $\bar{x} \pm DE$
210	8	7.75 $\pm$ 0.4b	7.83 $\pm$ 0.2	7.66 $\pm$ 0.1	7.41 $\pm$ 0.3	7.75 $\pm$ 0.0	10.00 $\pm$ 0.0	7.58 $\pm$ 0.1	9.33 $\pm$ 1.1	8.37 $\pm$ 0.0
	9	7.83 $\pm$ 0.5b	7.75 $\pm$ 0.2	7.58 $\pm$ 0.1	7.41 $\pm$ 0.3	7.83 $\pm$ 0.3	9.00 $\pm$ 1.7	7.83 $\pm$ 0.8	10.00 $\pm$ 0.0	8.36 $\pm$ 0.0
	10	7.90 $\pm$ 0.3b	7.83 $\pm$ 0.3	7.91 $\pm$ 0.1	7.66 $\pm$ 0.6	7.90 $\pm$ 0.3	10.00 $\pm$ 0.0	7.90 $\pm$ 0.1	9.33 $\pm$ 1.1	8.49 $\pm$ 0.2
	11	7.58 $\pm$ 0.6b	7.41 $\pm$ 0.3	7.33 $\pm$ 0.2	7.41 $\pm$ 0.3	7.41 $\pm$ 0.1	10.00 $\pm$ 0.0	7.50 $\pm$ 0.0	10.00 $\pm$ 0.0	8.29 $\pm$ 0.1
	12	7.98 $\pm$ 0.2b	7.33 $\pm$ 0.3	7.23 $\pm$ 0.2	7.08 $\pm$ 0.1	7.58 $\pm$ 0.1	10.00 $\pm$ 0.0	7.50 $\pm$ 0.2	9.33 $\pm$ 1.1	8.23 $\pm$ 0.2
215	8	8.00 $\pm$ 0.4b	7.91 $\pm$ 0.1	7.83 $\pm$ 0.2	7.71 $\pm$ 0.2	8.00 $\pm$ 0.4	10.00 $\pm$ 0.0	7.83 $\pm$ 0.2	9.33 $\pm$ 1.1	8.51 $\pm$ 0.3
	9	8.00 $\pm$ 0.5b	7.50 $\pm$ 0.6	7.83 $\pm$ 0.1	7.58 $\pm$ 0.6	7.91 $\pm$ 0.3	10.00 $\pm$ 0.0	8.08 $\pm$ 0.3	9.33 $\pm$ 1.1	8.47 $\pm$ 0.4
	10	8.31 $\pm$ 0.3a	7.58 $\pm$ 0.5	7.91 $\pm$ 0.0	7.91 $\pm$ 0.1	8.00 $\pm$ 0.5	10.00 $\pm$ 0.0	8.00 $\pm$ 0.5	10.00 $\pm$ 0.0	8.64$\pm$0.0
	11	7.00 $\pm$ 0.0c	7.08 $\pm$ 0.1	7.50 $\pm$ 0.0	7.5 $\pm$ 0.0	7.50 $\pm$ 0.0	10.00 $\pm$ 0.0	7.50 $\pm$ 0.0	10.00 $\pm$ 0.0	8.23 $\pm$ 0.0
	12	8.25 $\pm$ 0.4a	7.41 $\pm$ 0.1	7.41 $\pm$ 0.1	8.08 $\pm$ 0.3	7.98 $\pm$ 0.2	10.00 $\pm$ 0.0	7.91 $\pm$ 0.3	9.00 $\pm$ 1.0	8.45 $\pm$ 0.2

Note: Values are expressed as mean $\pm$ standard deviation ($\bar{X} \pm SD$). There were no significant differences between treatments ($p \leq 0.05$) except for the fragrance/aroma variable; within that column, different letters (a, b, and c) indicate significant differences ($p \leq 0.05$) among roasting treatments. Specialty coffee: score above eight. 6.00 Good 7.00 Very good 8.00 Excellent 9.00 Exceptional.

decreased with increased roasting time (Díaz; Ormaza; Rojano, 2018). Furthermore, Lee et al. (2015) and Moreira et al. (2017) suggest that the color changes from green to brown to black (in this case, remaining brown) is generated by melanoidins during caramelization, Maillard, and polymerization reactions, contributing to odor formation.

4.2 The sensory evaluation

4.2.1 Fragrance/aroma

Fragrance/aroma, is a crucial aspect of coffee quality assessment. In this study, the fragrance/aroma ratings ranged from 7.58 to 7.98 (very good) with an initial roasting temperature of 210 °C and from 7.00 to 8.31 (excellent) at an initial temperature of 210 °C, particularly for the naturally processed coffee.

Comparing these results with previous studies, (Juárez et al., 2021), evaluated Caturra coffee processed at 1,420 masl, obtaining scores of 7.25 for natural, 7.17 for honey, and 7.50 for washed. Similarly, Benítez and Campo (2018), assessed Bourbon coffee processed through washing, yielding scores of 7.75 and 8.0. The scores obtained in the current experiments surpass those reported by (Juárez et al., 2021), and (Benítez; Campo, 2018), suggesting a higher quality coffee.

Osorio (2021) suggests that the aroma of coffee is derived from chlorogenic acids, which are phenolic compounds. While we did not perform chemical analyses here, we recommend it be done in future research, given the exceptionally high scores obtained. Fragrance is perceived as a combination of the aroma of dry ground coffee and the scent when the infusion is prepared. Fragrance is evaluated by

smelling the particles placed in the cup before pouring water over the coffee, while aromas are perceived during the cupping process when water contacts the coffee as it decants.

4.3 Flavor

In terms of the flavor variable, the results obtained with an initial roasting temperature of 210 °C ranged between 7.3 and 7.8 (very good), while with an initial roasting temperature of 215 °C, they ranged from 7.1 to 7.9 (very good). Comparing with previous studies, (Juárez et al., 2021) reported values of 7.3 for natural coffee, 7.1 for honey coffee, 7.5 for washed coffee, and 7.9 for fermented coffee. On the other hand, Benítez and Campo (2018), obtained values of 7.7 and 8.0.

4.4 Aftertaste

In this variable, values ranging from 7.2 to 7.9 (very good) were found with an initial roasting temperature of 210 °C. Similar values, from 7.4 to 7.9 (very good) were found with an initial roasting temperature of 215 °C. (Juárez et al., 2021) found an aftertaste value of 7.3 for natural coffee, 7.1 for honey coffee, 7.5 for washed coffee, and 7.9 for fermented coffee. Meanwhile, Benítez & Campo, 2018, proposed a score of 7.5. These results are similar to those of the present study.

4.5 Acidity

In this category, values ranging from 7.0 to 7.6 (very good) were observed with an initial roasting temperature of 210 °C, while with an initial temperature of 215 °C, the range was from 7.5 to 8.0 (excellent). (Juárez et al., 2021) recorded values of 7.4 for natural, 7.4 for honey, 7.6 for washed, and 7.6 for fermented coffee, while Benítez & Campo, 2018 reported

values of 7.5 and 8.0. The values obtained by both authors are similar to those of the present research. Puerta (2013) suggests that the liveliness of acidity can be modified by increasing the fermentation and roasting time, which could be adapted to consumer tastes.

4.6 Body

This variable reports ranges between 7.4 and 7.9 (very good) with an initial roasting temperature of 210 °C and between 7.5 and 8.0 at an initial temperature of 215 °C, the latter score being considered excellent. (Juárez et al., 2021) recorded values of 7.1 for natural, 7.0 for honey, 7.4 for washed, and 7.2 for fermented, while Benítez & Campo, 2018 found values of 7.0 and 7.5, all values being very close. Osorio (2021) suggests that the body characteristic of a coffee is related to its lipid content (fatty acids and tocopherols). It would be informative to conduct a fatty acid profile analysis to verify this. The determination of body is based on the tactile sensation of the liquid in the mouth, particularly perceived between the tongue and the palate. Samples with a heavy body may receive a high score in terms of quality due to the presence of colloids in the infusion, although some with a light body produce a pleasant sensation. All of the presented results have a high rating, indicating a heavy body which suggests a good amount of lipids.

4.7 Uniformity

In this property, scores between 9.0 and 10 were obtained for an initial roasting temperature of 210 °C, while with an initial temperature of 215 °C, it had the maximum possible score of 10, which according to the SCA is classified as outstanding. Juárez et al. (2021) also recorded scores of 10 for natural, honey, washed, and fermented coffee. Benítez & Campo, 2018, meanwhile recorded lower scores of 8.0. The uniformity characteristic refers to the consistency of the flavor of the various cups of the tested sample, with a low score indicating different flavors across cups. In particular, the cupping protocol of the SCA (2015) indicates that five cups per sample should be evaluated, and two points are awarded for each cup that exhibits this quality, with a maximum of ten points if the cups are identical. In this case, the perfect score on uniformity denotes very high consistency.

4.8 Balance

This category comprises values ranging from 7.5 to 7.9 for an initial roasting temperature of 210 °C, while with an

initial temperature of 215 °C, this score ranged from 7.5 to 8.1. The highest-rated treatment was 215 °C for 9 minutes, which according to the SCA corresponds to excellent. (Juárez et al., 2021) recorded values of 7.3 for natural, 7.0 for honey, 7.5 for washed, and 7.5 for fermented. Meanwhile, the ratings by Benítez and Campo (2018) were 8.0. The values obtained by both (Juárez et al., 2021) and Benítez and Campo (2018) indicate that their coffee has a lower balance compared to those of the present investigation.

4.9 Sweetness

This attribute was rated with scores ranging from 9.3 to 10 (outstanding) for all treatments. (Juárez et al., 2021) recorded values of 10 for natural, honey, washed, and fermented coffee. The sweetness scores for Benítez and Campo (2018) were lower, with a value of 8.0. Sweetness is perceived as a result of the presence of certain carbohydrates. The opposite of sweetness in this context is bitterness, astringency, or “green” flavors. Sweetness is a characteristic of Arabica coffee varieties and is due to the presence of sugars (Quintero, 2013). All of the analyzed coffees described above belong to the high sweetness category.

4.10 Clean Cup

The results obtained in the present research for the clean cup variable are 10 (outstanding), similar to those obtained by Juárez et al. (2021), who recorded 10 for natural, honey, washed, and fermented, and similarly, Benítez and Campo (2018), reported a score of 10.

4.11 Notes of coffee aroma

In Table 4, a comparison is presented among the aroma notes obtained from the coffees evaluated by Juárez *et al.*, 2021, for the natural, honey, washed, and fermented coffees the green coffee beans were roasted for 20 min at 190 °C $\pm$ 10 °C medium, as well as those from Benítez & Campo, 2018, for profiles 3 and 4, and those from the present research. The coffees in all three studies were described by Q grader evaluators. The profile described by Juárez *et al.*, 2021, for a natural coffee presents aromatic notes similar to those in the current study at an initial roasting temperature of 210 °C, from nine minutes to twelve minutes—specifically apple, walnut, almond, and caramel. On the other hand, the washed coffee from Juárez *et al.*, 2021 resembles the notes described in profiles 3 and 4 from Benítez & Campo, 2018, specifically in terms of citrus, butter, and fruits.

Table 4: Comparison of Arabica coffee aroma notes among treatments and with previous publications

Time (min)	Current Study		(Juárez et al., 2021)				(Benítez; Campo, 2018)	
	210 °C	215 °C	Natural	Honey	Washed	Fermented	Profile 3	Profile 4
8	Fruity, vinous, peach, plum, tamarind, cinnamon, red fruits, yellow lemon	Vanilla, nut, spices, orange, ripe fruits, peach, floral, orange zest, and brown sugar	Apple, walnut, chocolate, almond, caramel, macadamia.	Wood and straw, almonds, caramel, honey, apple, lemon, vanilla.	Cinnamon, raisins, fig, vanilla, apple, citrus, almond, butter, caramel, dulce de leche	Cedar, tamarind, pineapple, tangerine, caramel, almond liqueur, vanilla, cognac, dried fig, vinous, papaya, tamarind, plum	Caramel, chocolate, butter, malt, fruity	Citrus, brown sugar, lemongrass, fruity, tar
9	Caramel, vanilla, spices, brown sugar, red fruits, citrus, and floral.	Brown sugar, floral, citrus blossoms, currant, and jasmine						
10	Fresh fruit, tropical fruit, peach, candies, ripe fruits, apple, and brown sugar	fruity, floral, maple, vanilla, cardamom, red apple, peach, and herbal.						
11	Nutmeg, grapefruit, cocoa, prunes, caramel, mild chocolate, burnt sugar, and citrus	Cocoa, floral, cherry, peach, spices, nutmeg, nuts, and butter.						
12	Vanilla, sweet, cocoa, chocolate, caramel, flan, and almonds	Dried fruits, sweet, floral, and buttery						

5 CONCLUSION

In summary, the Q grader-level tasters who evaluated the samples indicated that the highest scoring sample from the two roasting temperatures and five roasting times was the treatment 215 °C/10, although Table No. 3 shows that statistically, there are no significant differences ($p \leq 0.05$). It is worth noting that the main notes that emanated from this treatment, according to the, were fruity, floral, maple, cardamom, red apple, peach, herbal, and primarily “vanilla.” It is concluded that... (It must be in accordance with the objective of the work).

6 AUTHORS' CONTRIBUTION

Conceptual idea Rubí, M.; Mariezcurrena, M. D.; and Vargas, O. R.; Methodology design Mariezcurrena, M. D.; Vargas, G. A.; Data collection Vargas, O. R.; Data analysis and interpretation Mariezcurrena, M. D.; Ramírez, J. F.; and Vargas, O. R.; Writing and editing Vargas, O. R.; Rubí, M.; Mariezcurrena, M. D.; Vargas, G. A.; Ramírez, J. F.

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