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Sensory Characterization and Acceptance of Amazonian Robustas Coffee Brews by Consumers Using a Home-Use Test

Thayna Viencz ^{1,*}, Claudimara da Silva Portela ¹, Rodrigo Barros Rocha ², Enrique Anastácio Alves ², André Rostand Ramalho ², Rafael Carlos Eloy Dias ^{1,*} and Marta de Toledo Benassi ¹

¹ Departamento de Ciência e Tecnologia de Alimentos/DCTA-Cx. P. 10011, Universidade Estadual de Londrina/Uel, Londrina 86057-970, Brazil; martatb@uel.br (M.d.T.B.)

² Centro de Pesquisa Agroflorestal de Rondônia, Cx. P. 127, Empresa Brasileira de Pesquisa Agropecuária/EMBRAPA, Porto Velho 76815-800, Brazil; rodrigo.rocha@embrapa.br (R.B.R.); enrique.alves@embrapa.br (E.A.A.); andre.rostand@embrapa.br (A.R.R.)

* Correspondence: thayviencz@hotmail.com (T.V.); rafael.rafaeltam@gmail.com (R.C.E.D.)

Abstract: This study evaluated consumers' perceptions of beverages obtained from the intervarietal hybrids of *Coffea canephora*, Conilon and Robusta, produced in the Western Amazon, through a home-use test with 127 participants. An acceptance test and a Check-All-That-Apply procedure were applied. Two clones, BRS 2314 and BRS 2357, were studied (both in natural and fermented versions) and their roasted coffee composition was also evaluated. All beverages were described as having a mild aroma, roasted flavor, and slightly sour taste; consumers noticed both the effect of the fermentation process and genetics. Natural coffees had greater sensory acceptance than fermented ones. Natural coffees were most associated with a slightly bitter taste, and were well accepted by almost half of the participants, mainly women. Fermented coffees were both associated with fermented flavor, but also presented specific characteristics. BRS 2314F was most associated with a fruity flavor and slightly bitter taste and was well accepted by younger consumers with higher levels of education. BRS 2357F was most associated with tobacco flavor and bitter taste and was well accepted by older consumers with a lower education level and a higher coffee consumption frequency. The positive acceptance of *C. canephora* intervarietal hybrid beverages allowed us to confirm its material market potential.

Keywords: coffee beverages; BRS 2314; BRS 2357; *Coffea canephora*; fine Robusta; fermented coffee; natural coffee; CATA; sensory analysis; coffee quality



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1. Introduction

Coffee is one of the most popular beverages worldwide. The world's coffee production is expressive, estimated at 171.4 million bags of 60 kg for the coffee year of 2023/24; however, beverage consumption has been increasing faster by around 2% annually. In 2023, coffee consumption exceeded production by 4.9 million bags [1], so it is important to consider alternatives to the current marketing scenario to ensure coffee availability to industry, coffee shops, and consumers. Besides the *Coffea arabica* species, which is traditionally more consumed and valued, the *Coffea canephora* coffee has consistently stood out for its higher productivity and resilience against climate change, and recently, this species has been recognized as having potential for specialty coffees [2]. However, over the years, *Coffea canephora* has been regarded as a low-quality commodity, primarily used in the production of instant coffee or blended with *Coffea arabica* for roasted and ground coffee. Consequently, the average consumer is unfamiliar with roasted coffee beverages made exclusively from *C. canephora*.

Brazil is the leading coffee producer and exporter and the second-largest consumer in the world, with more than 30 regions of coffee production; the country is also the second-largest producer of *C. canephora* (17.3 million bags of 60 kg estimated for 2024) [3]. Studies

on *C. canephora* breeding have contributed to an improvement in agronomic parameters and beverage quality [4,5]. In Brazil, the coffee-growing region in the state of Rondônia, located in the Western Amazon, garners attention due to its substantial production volume and the integration of advanced technologies within a framework of family farming practices; this region is distinguished by its demonstrable commitment to sustainable production methods [6]. Over the span of 20 years, the state of Rondônia experienced a 75% reduction in coffee plantation area but recorded a 64% increase in production and a 518% increase in productivity. These outcomes are primarily attributed to the introduction of new techniques and improved coffee varieties [7]. Furthermore, in 2021, the region “Matas de Rondônia” achieved the first worldwide Geographical Indication for *C. canephora* [8].

We highlight the recent launch of the Amazonian Robustas cultivar, composed of 10 clones of *C. canephora* intervarietal hybrids of Conilon and Robusta, which exhibit a high degree of adaptability to the environmental conditions of the “Matas de Rondônia” region [5]. Besides the high productivity (over 60 bags ha⁻¹) and resistance to coffee leaf rust and root-knot nematode, Amazonian Robustas presented good beverage quality (≥70 points) with ratings ranging from commercially good to special, according to Fine Robusta Cupping [5,9]. In addition to the contributions of genetics, growing site, management, and harvest practices on the cup quality, the post-harvest fermentation of Amazonian Robusta coffees has already been used to produce unique beverages that are characterized by experts as presenting different nuances and offering more diversified coffees [10,11]. Additionally, as was recently highlighted by Teran [12], the assessment of Robusta coffee enables an understanding of the variations and similarities between this species and Arabica coffee, each occupying distinct roles within the coffee production chain.

Nonetheless, it has been recognized that the characterization and cup quality evaluation by experts do not always correspond to consumers’ opinions [13]. Bressani et al. (2021) [14] proposed the joint use of the sensory acceptance test and the Check-All-That-Apply (CATA) method to obtain a closer representation of consumers’ insights about coffee brews.

A more accurate method for evaluating consumer acceptance involves testing a product under typical usage conditions, reflecting the latest trend in consumer testing methodologies. The home-use test allows participants to actively prepare and consume the product as part of their daily routine, forming opinions based on real-world usage. Although these tests can be more costly and time-consuming than laboratory evaluations, they offer significant advantages in terms of data validity. The primary concern in a home-use test is measuring the overall product acceptability; however, as more time is available to complete the scoresheet, more information can be collected regarding the consumers’ perception [15–17].

In a previous study of our research group with Amazonian Robustas, Viencz et al. (2024) [18] described the sensory profile and the dominant attributes of intervarietal hybrid coffee beverages using the methodologies of Flash Profile and Temporal Dominance of Sensations. The research was focused on two genotypes (clones BRS 2314 and BRS 2357) that presented differences in their phenotypic and genotypic characteristics representing the variability of the cultivar; they were studied in their natural and fermented versions. The methodologies employed allowed us to discriminate both the genetics and the presence of the fermentation process, and specific characteristics were described for each beverage. Conversely, it is not known if the consumer would perceive these characteristics in a similar way when preparing the beverages at home or even if these differences would impact the acceptance of the product.

Considering these remarks, this study aimed to evaluate the acceptance and sensory characterization of beverages of the intervarietal hybrid clones BRS 2314 and BRS 2357 (in natural and fermented versions) produced in the Western Amazon, as perceived by the consumers, based on a home-use test of acceptance and on the CATA method. Some compounds of interest, based on their sensory effect and/or impact on coffee cup

quality—caffeine, trigonelline, chlorogenic acids, and diterpenes—were also evaluated in the roasted and ground coffee used to prepare the beverages.

2. Materials and Methods

2.1. Material

C. canephora clonal coffees, intervarietal hybrids of Conilon and Robusta varieties from cultivar Amazonian Robustas, were provided by Embrapa Rondônia (Porto Velho, Rondônia, Brazil). The coffee fruits were harvested during the 2021 crop at the cherry stage, from the experimental field of Ouro Preto do Oeste/RO (10°43'55.3'' S and 62°15'23.2'' W; 245 m of altitude).

Two hybrid clones—BRS 2314 and BRS 2357—were selected for this study. They presented differences regarding agronomical [5,19], compositional [20], and sensory characteristics [18]. Beverages produced from the studied material had their characteristics described by three experts (cup quality and sensory attributes/notes) using the Fine Robusta Cupping protocol [5,9]; information is available in Table S1.

All coffee fruits were washed to remove impurities and defects. One part of the fruits of each coffee cultivar was naturally dried (traditional processing), and another part was anaerobically fermented for 15 days and then dried (fermented processing). The green beans were sieved (sieve 15 and larger) and stored in paper packaging at room temperature until roasting.

For the roasting process, a Probatino roaster (Probat Leogap, Curitiba, Brazil) was used under the following conditions: an initial temperature of 150 °C and a final temperature of 200 °C, by approximately 11 min. The roasting degree was monitored according to its changes in color and was standardized between Agron #65 and #55, with an average weight loss of 14%. The roasted coffees were ground in a Bunn coffee Mill grinder G3A (Bunn-O-Matic Corporation, Springfield, MO, USA) to a medium granulometry, adequate for the preparation method (French press).

More information on the experimental field characteristics, harvest, and post-harvesting procedures, as well as roasting and grinding conditions are available in the work of Viencz et al. (2024) [18].

The coffees had a medium-light roast, with a lightness of 35 ± 2 and a hue of 63 ± 2 . Moisture was determined at 105 °C for 7 min, and an average value of 3.5 ± 0.3 g 100 g⁻¹ was observed. The results were used to calculate the concentration of the components on a dry weight basis (db). Analyses of color and moisture were carried out on ground coffees (in triplicate and duplicate determinations, respectively).

For each sample, one part of the ground coffee was packed in plastic bags and kept refrigerated (8 °C) until the chemical composition analysis was conducted. The other part was packed in laminated bags hermetically sealed with a portable sealer model Selamil 3223 (R. Baião Máquinas e Equipamentos, Ubá, Brazil) and included in each kit for evaluation at home (described in Section 2.3).

2.2. Chemical Composition Characterization of the Roasted and Ground Coffee

All analyses were performed with a duplicate extraction process and a duplicate of analysis. The content of all the compounds was expressed as g 100 g⁻¹.

The following materials were used: 0.22 µm nylon syringe filters; 0.45 µm nylon membranes (Filtrilo, Colombo, Brazil); 0.40 µm qualitative filter paper; and water obtained with a purification and filtration system (Elga Purelab Option-Q, Veolia Water Solutions and Technologies, High Wycombe, UK).

A Waters ACQUITY® UPLC (Waters, Milford, MA, USA), equipped with the Empower 3 software, with an automatic sample injector, quaternary solvent pumping system, and a diode array UV-Vis detector was used for chromatographic analyses.

The identification of the compounds of interest was based on retention times and UV spectra. The quantification was carried out by external standardization using 6-point analytical curves, with triplicate measurements.

2.2.1. Analysis of Caffeine, Trigonelline, and Chlorogenic Acids

The preparation of the extract and the determination of the water-soluble compounds were performed as described by Viencz et al. (2023) [20].

Coffee samples (0.50 g) were extracted with water (30 mL at 80 °C) for 10 min, filtered, and then diluted with water (10:90 *v/v*). The chromatographic analysis was performed using a gradient elution of acetic acid/water (5:95 *v/v*) (A) and acetonitrile (B) as follows: 0 to 5 min 5% of B; 6 min 13% of B; and 25 min 13% of B, with a flow rate of 0.5 mL min⁻¹.

HPLC-grade acetonitrile (Merck, Darmstadt, Germany), acetic acid (purity ≥ 99.8%, Anidrol, Diadema, Brazil), standards of caffeine, trigonelline, and 5-caffeoylquinic acid (5-CQA) (Aldrich, Saint Louis, MO, USA), and a Spherisorb ODS-1 column (150 mm × 4.6 mm, 3 µm; Waters, Milford, CT, USA) were used.

Detection was set at 260 nm for trigonelline, 272 nm for caffeine, and 320 nm for chlorogenic acids, and an injection volume of 10 µL was applied. The analytical curves were in the following ranges: 10 to 60 µg mL⁻¹ for caffeine, 1 to 30 µg mL⁻¹ for trigonelline, and 1 to 60 µg mL⁻¹ for 5-CQA. The total chlorogenic acid (CGA) content was estimated by the sum of the areas of compounds detected at 320 nm, using 5-CQA as a standard for quantification.

2.2.2. Analysis of Kahweol, Cafestol, and 16-O-Methylcafestol

The extraction and the determination of the diterpenes were performed as previously described [20]. Coffee samples (0.20 g) were hot saponified and extracted with HPLC-grade methyl *tert*-butyl ether (Acrós Organics, Morris Plains, NJ, USA). Ethanol of 96% analytical grade (Êxodo Científica, Hortolândia, Brazil) and potassium hydroxide of 85% analytical grade (Panreac, Barcelona, Spain) were also used.

The chromatographic analyses were performed through isocratic elution with water/acetonitrile (45:55 *v/v*) at a flow rate of 0.7 mL min⁻¹. The detection was set at 230 nm for 16-*O*-methylcafestol (16-OMC) and cafestol and 290 nm for kahweol, and an injection volume of 3.00 µL was applied.

Standard 16-OMC (Aldrich, Saint Louis, MO, USA) and kahweol and cafestol (Axxora, San Diego, CA, USA) as well as a Supelcosil LC-18 column (150 mm × 3 mm, 3 µm; Supelco Park, Bellefonte, PA, USA) were used.

The analytical curves of the diterpenes were in the following ranges: 1 to 200 µg mL⁻¹ for kahweol, 50 to 300 µg mL⁻¹ for cafestol, and 2 to 400 µg mL⁻¹ for 16-OMC. The total diterpene content was determined considering the sum of contents of kahweol, cafestol, and 16-OMC.

2.3. Sensory Analysis of Coffee Brews

2.3.1. Sensory Acceptance

This study was approved by the Human Research Ethics Committee of Universidade Estadual de Londrina, Brazil (Certificate of Presentation for Ethical Consideration 42691221.0.0000.5231), where the study was conducted. The research was carried out during the COVID-19 pandemic, so the use of a home-use test had the advantage of maintaining social distancing which was necessary at the time. To characterize the 127 participants, their personal information (gender, age, educational level, form and frequency of coffee consumption, use of sugar/sweetener) was collected.

The trial participants also received a box with a kit to standardize the brewing procedure and sensory evaluation. Stone and Sidel (2004) [16] emphasized that preparation instructions for home-use tests must be complete in terms of how the product is to be used, along with directions for the questionnaire completion, and that the test design and instructions should be kept uncomplicated and unambiguous since there is no experimenter available to the participants at the time of the preparation and evaluation. It is also important to ensure that the test is performed under actual use conditions [15]; considering that many Brazilians usually consume sweetened coffee [21], the participants were given

the option to prepare it according to their habit, as long as they informed if there was added sugar.

The kit consisted of a French press coffee maker (350 mL) (Fratelli, São Paulo, Brazil), a digital thermometer to check the water temperature (Akso, São Leopoldo, Brazil), a food-grade polycarbonate plastic measuring cup (100 mL) to measure the volume of water (Nalgon, Itupeva, Brazil), disposable 100 mL polystyrene cups (Totalplast, Itaquaquecetuba, Brazil) to consume the beverages, disposable plastic spoons to homogenize the beverage (Strawplast, São Ludgero, Brazil), 5 g sugar sachets (União, Rio de Janeiro, Brazil) in the case of consumers that use sugar, and a personalized notepad. The French press method was chosen due to the simplicity of the process, making it easy to standardize the brewing procedure. The notepad had instructions on the brewing preparation, how to proceed with the sensory assessment at home, and score sheets to inform the results of each evaluation. The kit also included the samples: five laminated sealed packages with roasted and ground coffee (8 g)—one coded as a test and four coded with numbers of three random digits.

The participants were instructed to prepare the test coffee first to familiarize themselves with the brewing procedure. Afterward, they should prepare the beverages in the order indicated on the score sheets (identified by the code number) arranged sequentially. The order of sample presentation was randomized for each participant. It was suggested that the participants prepare the beverages at their usual coffee time, each on a different day, or even two beverages on the same day, with a break between them.

To perform the coffee brewing process, the participants were instructed to preheat the French press with hot water, then dispose of the entire package content (8 g of coffee) into the French press and add 100 mL of water at 92 to 96 °C. After stirring with a spoon, they should place the top of the French press with the plunger raised and let the coffee infuse. After 4 min, they should press the plunger to filter the beverage, serve it in the polystyrene cup, and, for consumers of sweetened beverages, sweeten it using the sachet content (while noting down how much sugar they use). This instruction was described in detail in the notepad, and the participants were also given an instructional video on how to carry out the preparation to help clarify doubts about the brewing procedure and coffee maker use. After each beverage consumption, the participants had to inform their assessment of the beverage on the corresponding score sheet and sanitize the French press for the subsequent preparation.

The acceptance of beverages was assessed using a 10 cm hybrid hedonic scale, which is a linear scale anchored at the ends and in the middle with the expressions “0 = extremely disliked”, “10 = extremely liked”, and “5 = neither liked nor disliked”, respectively [22]. The assessors rated the beverages based on their perceptions after consumption but could also consider other impressions during the brewing preparation, such as the aroma.

2.3.2. Check-All-That-Apply

After each acceptance test, the participants were asked to check a list (in Portuguese language) of 20 attributes—mild and intense aromas; bitter, slightly bitter, sweet, slightly sweet, sour, and slightly sour tastes; roasted, chocolate, caramel, fruity, citrus fruits, spices, honey, chemical/medicinal, fermented, and tobacco flavors; watery and full-bodied texture—and select which one(s) applied to the beverage, in a CATA approach. The list was defined based on previous research with *C. canephora* brews [18,23,24]. The presentation order of the terms was randomized for each sample and participant, as described by Mori et al. (2018) [23]. Results were reported as the frequency of citation (FC) for each term.

2.4. Data Analysis

Chemical composition and sensory acceptance data were analyzed by ANOVA—one-way and two-way (samples and participants as the source of variation), respectively—and Fisher’s LSD test ($p \leq 0.05$) using the Statistica 7.1 package software (Statsoft Inc., Tulsa, OK, USA).

Using the acceptance data matrix, a plot of consumers was obtained. The multidimensional scaling technique associated with Hierarchical Cluster Analysis was applied using Senstools 2.3.28 package software (OP&P Product Research/Essensor, Wageningen, The Netherlands).

Check-All-That-Apply data were analyzed using Cochran's Q test ($p \leq 0.10$) with critical difference (Sheskin) and Correspondence Analysis, using the XLSTAT 2021.3.1 package software (Addinsoft Inc., New York, NY, USA). Only terms with FI $\geq 10\%$ were considered for the description of the samples.

3. Results and Discussion

3.1. Chemical Composition Characterization of the Roasted and Ground Coffee

For the water-soluble compounds, the trigonelline was the only parameter for which no differentiation among samples was observed, with a mean content of $0.66 \text{ g } 100 \text{ g}^{-1}$. The caffeine content was between 2.64 and $2.92 \text{ g } 100 \text{ g}^{-1}$, and the CGA content was between 3.34 and $4.21 \text{ g } 100 \text{ g}^{-1}$ (Table 1). Contents of 5-CQA (the main isomer of the CGA group) were, on average, 32% of the total CGA, varying from 0.97 to $1.39 \text{ g } 100 \text{ g}^{-1}$. The compound contents were within the range reported in the literature for *C. canephora* coffees with differences in genetics and roasting degrees: from 1.46 to 3.57 g for caffeine 100 g^{-1} , 0.07 to 1.15 g for trigonelline 100 g^{-1} , 2.00 to 6.37 g for CGA 100 g^{-1} , and 0.21 to 2.43 g for 5-CQA 100 g^{-1} (31 to 40%) [20,25–33].

Table 1. Contents of water-soluble compounds and diterpenes ($\text{g } 100 \text{ g}^{-1}$) and caffeine/total diterpenes ratio for *C. canephora* coffee (BRS 2314 and BRS 2357 hybrid clones) in natural and fermented versions.

Compounds	BRS 2314		BRS 2357	
	Natural	Fermented	Natural	Fermented
Water-soluble compounds				
Caffeine	$2.89^a \pm 0.04$	$2.64^c \pm 0.03$	$2.72^b \pm 0.03$	$2.92^a \pm 0.00$
Trigonelline	$0.67^a \pm 0.03$	$0.65^a \pm 0.01$	$0.66^a \pm 0.01$	$0.66^a \pm 0.02$
Chlorogenic acids	$4.21^a \pm 0.07$	$3.83^b \pm 0.13$	$3.34^c \pm 0.12$	$3.85^b \pm 0.09$
Diterpenes (D)				
Total diterpenes	$0.555^a \pm 0.062$	$0.582^a \pm 0.028$	$0.450^b \pm 0.067$	$0.432^b \pm 0.047$
Cafestol	$0.467^a \pm 0.051$	$0.491^a \pm 0.031$	$0.359^b \pm 0.061$	$0.338^b \pm 0.045$
16-O-methylcafestol	$0.088^a \pm 0.011$	$0.092^a \pm 0.005$	$0.091^a \pm 0.006$	$0.094^a \pm 0.002$
Caffeine/total diterpenes ratio	$5.27^{bc} \pm 0.67$	$4.54^c \pm 0.26$	$6.16^{ab} \pm 0.98$	$6.82^a \pm 0.74$

Mean (duplicate of extraction and analysis, $n = 4$) \pm standard deviation; different letters in the same line indicate a significant difference between clones (Fisher's LSD test, $p \leq 0.05$).

Regarding the diterpenes, the absence of kahweol (below the method's detection limit) and no difference for 16-OMC content (mean value of $0.091 \text{ g } 100 \text{ g}^{-1}$) was observed. Total content of diterpenes was between 0.432 and $0.582 \text{ g } 100 \text{ g}^{-1}$, and cafestol content varied from 0.338 to $0.491 \text{ g } 100 \text{ g}^{-1}$ (Table 1). These compounds were also within the range reported for *C. canephora* coffees in the literature: 0.192 to 0.742 g of total diterpenes 100 g^{-1} , 0 to 0.044 g of kahweol 100 g^{-1} , 0.068 to 0.491 g of cafestol 100 g^{-1} and 0.026 to 0.433 g of 16-OMC 100 g^{-1} [20,26,29,34–39].

When comparing natural coffees, clone BRS 2314 exhibited higher concentrations of caffeine, CGA, cafestol, and total diterpenes (Table 1). This trend was similarly observed in previous research with the same material from a different season (2020), suggesting that these differences are likely attributable to genetic characteristics [20].

For the caffeine/total diterpene ratio, proposed as an indicative parameter of coffee species [40], the values (Table 1) were also close to those previously reported for both

clones [20]. These characteristics help to understand the impact of the botanical variety on the genetic crosses, since the composition profile of these clones is closer to the ones usually described for Robusta rather than for Conilon coffee [20,25,32,37,38,41].

The effect of fermentation on the composition varied according to the clone assessed. Still, after the process, clone BRS 2314 remained with higher contents of total diterpenes and cafestol than clone BRS 2357. The association of high contents of cafestol and total diterpenes with high cup quality was first reported by Barbosa et al. (2019) [42] for *C. arabica* from coffee quality competitions, and next described by Viencz et al. (2023) [20] for *C. canephora* coffees (Robustas and intervarietal hybrids). Our results agree with this statement since clone BRS 2314—previously described as having a higher potential for the specialty coffee market [4,5]—received higher quality scores (Table S1).

3.2. Sensory Analysis of Coffee Brews

The panel consisted of 127 regular coffee consumers (58 men and 69 women) above 18 years old, most of whom had a high level of education (88%). Most of them consumed coffee brews prepared with roasted and ground coffee 1 to 3 times daily; 61% of the participants did not use sugar, and 39% usually sweetened their beverages. For those who used sugar, they were instructed to use a quarter to one sugar sachet (5 g) for 100 mL of the beverage, consistent with the amount described by Portela et al. (2024) [43] for most Brazilian consumers of Arabica sweetened coffee brews. Despite the lesser proximity of Brazilian consumers with *C. canephora* coffee, more than half of the panel (66 participants) reported at least having heard the terms Conilon or Robusta. Detailed information is available in Table S2.

3.2.1. Sensory Acceptance

All beverages from the intervarietal hybrids of *C. canephora* scored higher than 5 (on a 10 cm hybrid hedonic scale), which represents the acceptance by consumers. Natural coffee beverages from clones BRS 2314 and BRS 2357, with a mean score of 6.93, were more accepted ($p \leq 0.05$) than their fermented versions (6.23 and 5.92, respectively) (Table 2). Some studies pointed to the acceptance of Conilon and Robusta beverages with scores from 3.8 to 5.7 on a nine-point scale [17,44,45]; other research reported values with scores from 5.9 to 7.1 on a 10 cm hybrid scale for *C. canephora* coffee brews [46,47], similarly to the values found in our study.

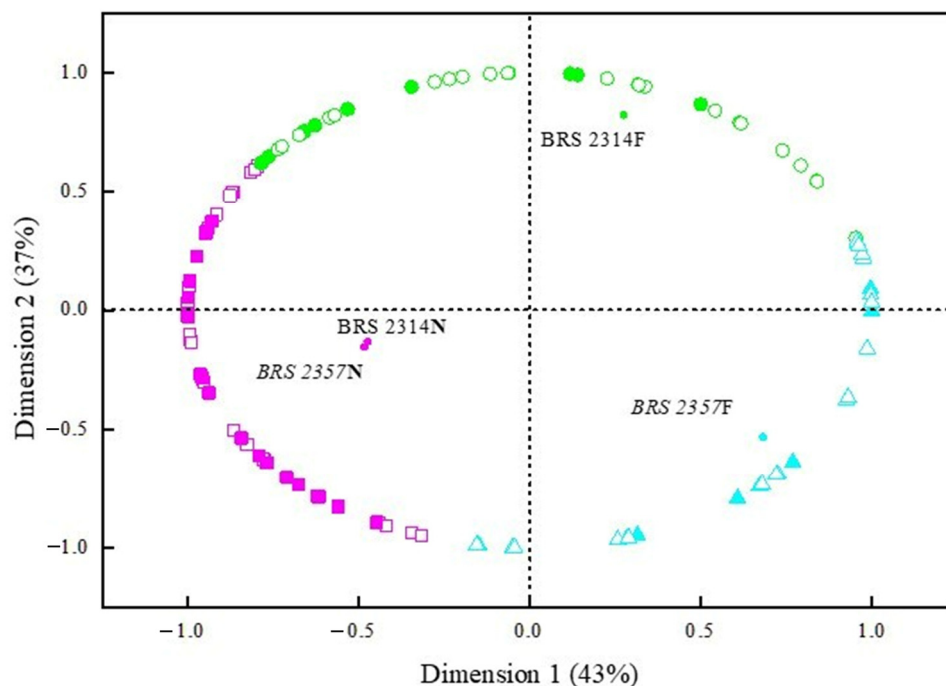


Figure 1. Acceptance plot of *C. canephora* brews using the multidimensional scaling technique and Hierarchical Cluster Analysis: configuration of the samples and participants. Each group of consumers is represented by the following symbols: Group I (■ with sugar, □ no sugar; BRS 2314N and BRS 2357N coffee brews); Group II (● with sugar, ○ no sugar; BRS 2314F coffee brew); Group III (▲ with sugar, △ no sugar; BRS 2357F coffee brew).

Table 2. Acceptance¹ of the *C. canephora* brews considering the total panel and the groups defined in the consumers' plot.

Participants/ Coffee Brews	Total	Groups ²		
		I	II	III
Number of consumers (% of the panel)	127 ²	57 (45%)	37 (29%)	32 (25%)
BRS 2314N	6.93 ^a ± 1.94	7.64 ^a ± 1.62	6.20 ^b ± 2.15	6.41 ^b ± 1.73
BRS 2314F	6.23 ^b ± 2.14	5.10 ^b ± 2.03	7.78 ^a ± 1.26	6.34 ^b ± 1.93
BRS 2357N	6.92 ^a ± 1.97	7.43 ^a ± 1.84	6.21 ^b ± 1.81	6.73 ^b ± 2.09
BRS 2357F	5.92 ^b ± 2.28	5.07 ^b ± 1.78	5.01 ^c ± 2.13	8.34 ^a ± 1.10

¹ Mean ± standard deviation; different letters in the same column indicate a significant difference (Fisher's LSD test, $p \leq 0.05$) (0 = extremely disliked, 10 = extremely liked, 5 = neither liked nor disliked). ² Groups are defined in Figure 1; one participant did not fit into any group. Coffee brews: BRS 2314 and BRS 2357; N corresponds to natural and F to fermented ones.

For a more comprehensive evaluation, the consumers were segmented (Figure 1); the first two dimensions of the plot accounted for 80% of the variance.

Three groups of consumers were identified; one participant did not fit into any group and was removed from the analysis (Table 2, Figure 1).

Almost half of the participants (57 consumers, 45%) preferred natural coffee brews; they are located on the left side of the sample plot (Group I). They scored around 7.5 for BRS 2314N and BRS 2357N, which is higher than the mean scores of the panel, and were indifferent to both fermented brews (Table 2, Figure 1). This group was characterized by a greater presence of women (66.7% of the total) who were more aware (54.4%) of the terms Conilon/Robusta (Table 3).

Table 3. Demographic data and personal information of participants considering the total panel and the groups defined in the consumer plot ¹.

Participants	Description	Groups ²			
		Total (n = 127)	I (n = 57)	II (n = 37)	III (n = 32)
Gender	Male	46	33	57	56
	Female	54	67	43	44
Age	Up to 30 years old	47	42	62	38
	31 to 50 years old	40	44	30	47
	Over 51 years old	13	14	8	16
Educational level	Intermediate	12	11	3	22
	High	88	89	97	78
Frequency of daily consumption	1 to 3 times	82	81	86	78
	>3 times	18	19	14	22
Use of sugar/sweetener	Yes	39	42	41	31
	No	61	58	59	69
Have you ever heard the term Conilon or Robusta?	Yes	52	54	46	44
	No	48	46	54	56

¹ Expressed as a percentage of participants (%) within the total panel or each group; n = number of consumers. ² One participant did not fit into any group; groups are described in Figure 1.

The other two groups were formed by participants who preferred one of the fermented coffees. Group II (29% of participants), located at the top of the sample plot, corresponded to those who preferred the BRS 2314F (mean score of 7.78), and Group III (25% of participants), located at the bottom right, to those who preferred the BRS 2357F (mean score of 8.34) (Table 2, Figure 1). The participants in Group II were younger, had a higher level of education, and were also indifferent to BRS 2357F. The participants in Group III were older, had a low degree of education and a higher coffee consumption frequency than the overall panel, and stood out for accepting all beverages (Table 3, Figure 1).

It was noticed that the fermentation process had a great impact on the beverages' acceptance: coffee brews with fermented beans were less accepted by some consumers (Group I) but allowed us to obtain products that were preferred by different participants (Groups II and III) (Figure 1, Table 2). It must be considered that fermented coffees, even that of the Arabica species, are still less usual in the Brazilian market.

Natural coffees stood out for their good acceptance, with average scores of above 6.2 for all consumer groups (Table 2). It is interesting to observe that, although clone BRS 2314 had a composition profile indicative of the greater potential for high cup quality (Table 1) and received higher quality scores (Table S1), the consumers liked the beverages made of BRS 2314N and 2357N equally. These results reinforce the need for consumer studies to complement quality assessments by experts.

3.2.2. Check-All-That-Apply

No difference among beverages was observed for 50% of the CATA attributes (Table 4), indicating that many characteristics used in the list were either perceived in a similar way for all samples or did not characterize the beverages. Some attributes, despite not discriminating the samples, showed a considerable number of citations, allowing us to obtain a general characterization of the set of intervarietal hybrids of *C. canephora* beverages studied, such as mild aroma (63% of citation), roasted flavor (40%), and slightly sour taste (29%). Consumers had no consensus regarding the body of the coffee brews, with 49 and 47% citing watery and full-bodied texture attributes, respectively. Other attributes had few citations, such as chocolate flavor (15%), indicating that consumers considered it less to characterize *C. canephora* beverages.

Table 4. Frequency of term citation for *C. canephora* brews (BRS 2314 and BRS 2357) in natural and fermented versions.

Attributes	<i>p</i> -Value	BRS 2314		BRS 2357		FC (%)
		Natural	Fermented	Natural	Fermented	
Aroma						
Mild	0.201	0.701 ^a	0.598 ^a	0.614 ^a	0.591 ^a	63
Intense	0.340	0.291 ^a	0.386 ^a	0.378 ^a	0.362 ^a	35
Taste/Flavor						
Roasted	0.525	0.441 ^a	0.378 ^a	0.417 ^a	0.370 ^a	40
Bitter	0.009	0.244 ^b	0.260 ^{ab}	0.362 ^{ab}	0.402 ^a	32
Slightly bitter	<0.001	0.496 ^a	0.512 ^a	0.417 ^a	0.260 ^b	42
Chocolate	0.668	0.126 ^a	0.142 ^a	0.173 ^a	0.165 ^a	15
Sour	0.480	0.142 ^a	0.094 ^a	0.102 ^a	0.134 ^a	12
Slightly sour	0.266	0.268 ^a	0.354 ^a	0.276 ^a	0.276 ^a	29
Sweet	0.032	0.197 ^a	0.102 ^{ab}	0.157 ^{ab}	0.094 ^b	14
Slightly sweet	0.970	0.220 ^a	0.205 ^a	0.228 ^a	0.220 ^a	22
Caramel	0.042	0.142 ^a	0.118 ^{ab}	0.134 ^{ab}	0.047 ^b	11
Fruity	0.033	0.094 ^b	0.205 ^a	0.110 ^{ab}	0.165 ^{ab}	14
Citrus fruits	0.069	0.071 ^{ab}	0.094 ^{ab}	0.039 ^a	0.126 ^b	8
Fermented	<0.001	0.079 ^{bc}	0.165 ^{ab}	0.039 ^c	0.236 ^a	13
Honey	0.290	0.087 ^a	0.055 ^a	0.031 ^a	0.063 ^a	6
Chemical/medicinal	0.004	0.031 ^a	0.094 ^{ab}	0.039 ^a	0.134 ^b	7
Tobacco	0.077	0.150 ^b	0.197 ^b	0.157 ^b	0.260 ^a	19
Spices	0.661	0.087 ^a	0.071 ^a	0.102 ^a	0.110 ^a	9
Body/texture						
Watery	0.146	0.512 ^a	0.559 ^a	0.425 ^a	0.465 ^a	49
Full-bodied	0.102	0.457 ^a	0.402 ^a	0.551 ^a	0.488 ^a	47

Numbers followed by different letters in the same line show significant differences between beverages (Cochran's Q test, $p \leq 0.10$). Italic: average citation frequency (FC) $\geq 10\%$.

The literature offers limited information on the sensory description and terminology used for *C. canephora* coffee beverages. Mori et al. (2018) [23] reported the term full-bodied for Conilon coffees; Condelli et al. (2022) [48] reported a roasted character for Robusta coffees; and both reported that bitter, strong, and astringent were the most relevant attributes to characterize Conilon and Robusta brews, respectively. Braga et al. (2022) [49] reported bitter and slightly sweet tastes for blends of Arabica and Robusta coffees.

Considering the specific characteristics of each sample, significant differences among beverages were observed for 7 out of the 20 CATA attributes ($p \leq 0.10$): caramel, fruity, fermented, and tobacco flavors; sweet, bitter, and slightly bitter tastes (Table 4).

The Correspondence Analysis enabled the discrimination between natural and fermented coffees (dimension 1, accounting for 76% of the inertia) and between clones (BRS 2314 and BRS 2357) (dimension 2, 19% of the inertia) (Figure 2). It is worth noting that in the sensory description of beverages using CATA (Figure 2), the sample location was like the one obtained in the consumer plot (Figure 1).

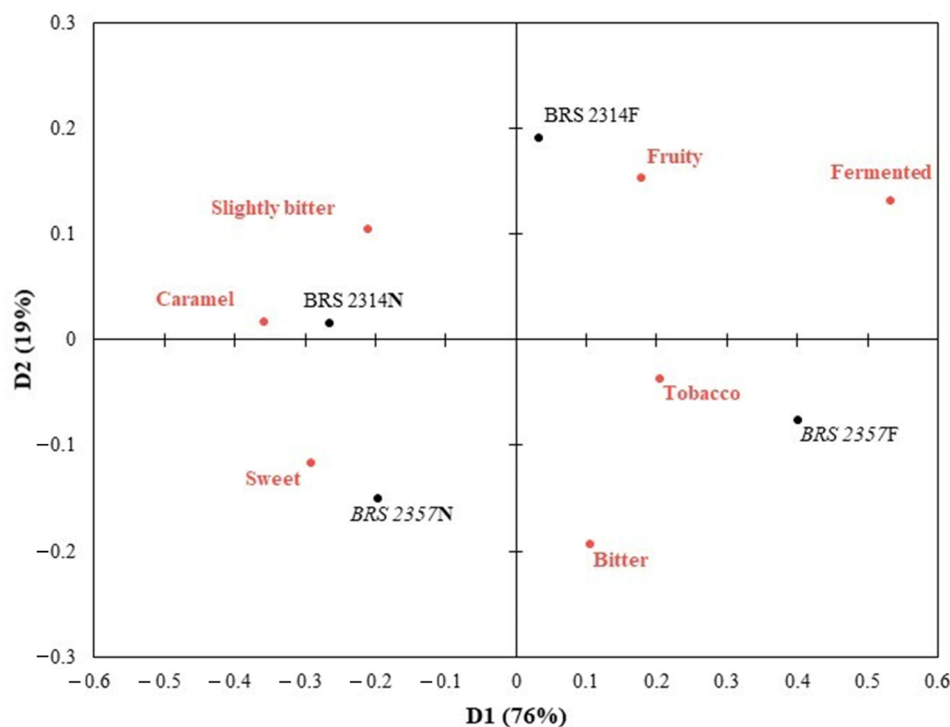


Figure 2. Correspondence Analysis plot for the description of *C. canephora* brews using Check-All-That-Apply. Coffee brews: BRS 2314 and BRS 2357; N corresponds to natural coffees, F to fermented ones. Attributes are presented in red.

In general, natural coffees were most associated with a slightly bitter taste and were more often cited as presenting a sweet and caramel taste; fermented coffees were associated with fruity, fermented, and tobacco flavors and bitter taste (Table 4, Figure 2).

Very little information in the literature on *C. canephora* fermentation includes a sensory approach. For *C. arabica*, a diversification and greater complexity in the profile of volatile compounds is usually described with the process, enhancing the Arabica-characteristic sensory attributes such as fruity and sweet flavors [50,51]. For yeast fermentation of *C. canephora* coffees, Tang et al. (2020) [52] reported an increase in aromatic compounds associated with sweet and fruity notes, and a similar behavior was described by Prakash et al. (2022) [53]. In the study by Alves et al. (2020) [10], which used semi-carbonic maceration for anaerobic fermentation (the same sprouting process applied in this research), Amazonian Robustas beverages were characterized by trained assessors; the attributes of sweet taste along with caramel flavor were used for natural coffees, and bitter taste in addition to fruity flavor for fermented ones.

The literature did not mention the development of tobacco flavor with fermentation. However, this attribute has already been described as dominant for Robusta coffees from the Amazon region [18,24]. The hypothesis is that the fermentation process may have enhanced the tobacco flavor, similar to what is described for increasing characteristic attributes of Arabica coffee. It is an interesting point, since tobacco flavor was described as responsible for positive emotions (content, good, and pleasant) [54].

BRS 2314N and BRS 2357N beverages, preferred by the same group of participants (Figure 1), were described in a similar manner: they were associated with the attributes of caramel flavor and sweet taste. In comparison, BRS 2314N was located close to the attribute slightly bitter taste, while BRS 2357N was closer to bitter taste (Figure 2).

Coffee brews produced with fermented beans, which were preferred by different groups of consumers (Figure 1), were both associated with fermented flavors, but they were also described as being more differentiated than the natural ones; BRS 2357F was most

associated with tobacco flavor and with a bitter taste, and BRS 2314F with fruity flavor and a slightly bitter taste (Figure 2).

Considering the consumers' habits, *C. canephora* coffee is a less usual material for roasted coffee beverages. However, some of the sensory attributes observed in our study, such as caramel, fruity, and tobacco, were also reported in the characterization of natural [48] and fermented [14] Arabica coffee brews by consumers using the CATA method, justifying the good acceptance achieved by the studied material (Table 2).

Regarding the study's limitations, it should be considered that our research was limited to participants mostly aged between 20 and 60 and with a high level of education; future studies could address a wider variation in the consumer profile.

4. Conclusions

The consumers accepted all *C. canephora* intervarietal hybrid beverages even though they had noticed both the effect of the fermentation process and the genetics. In general, the coffee beverages were characterized by a mild aroma, roasted flavor, and slightly sour taste. Natural coffee brews (BRS 2314 and BRS 2357) were well accepted by almost half of the participants, mainly women, and were mostly associated with a slightly bitter taste. The fermented coffee brews were both associated with fermented flavor, but also presented specific characteristics. The beverage of BRS 2314F, mostly associated with a fruity flavor and a slightly bitter taste, was well accepted by younger and more educated consumers. BRS 2357F produced a beverage primarily associated with a tobacco flavor and a bitter taste, and it was well accepted by older, less educated consumers with a higher frequency of coffee consumption.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/beverages10030057/s1>, Table S1: Characteristics of cup quality and sensory attributes/notes of *C. canephora* coffee brews described by experts; Table S2: Characterization of the sensory panel.

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