

Evaluation of the productivity and organoleptic characteristics of four Arabica coffee genotypes in Andil

Evaluación de la productividad y las características organolépticas de cuatro genotipos de café arábigo en Andil

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Abstract: Coffee is one of the main products grown in the southern part of Manabí. The objective of the study is to evaluate the productivity and organoleptic characteristics of four Arabica coffee genotypes (Sarchimor, Bourbon Rojo, Bourbon Amarillo, and Catuai). A completely randomised block design (CRBD) with five replicates was used, and Tukey's test at 5% was applied to identify the best performing treatments. In the organoleptic analysis, three processing methods were used per genotype: natural, honey and washed. In the production variables, the results did not show statistically significant differences between treatments, although Sarchimor recorded the highest productivity values and Bourbon Amarillo the lowest. In terms of granulometry, Sarchimor had larger dimensions in ripe fruit (length: 14.08 mm; width: 14.02 mm; thickness: 11.96 mm). In green coffee, no significant differences were observed; however, Sarchimor stood out with the highest proportion in the 15 mm sieve and good flotation performance (5.90%). In Brix degrees, Bourbon Rojo obtained the highest sucrose content (26.3), while no statistical differences were found in seed classification. In terms of organoleptic analysis, the natural and honey Sarchimor treatments achieved the highest scores (82.5), while washed Bourbon Rojo obtained the lowest rating (78.3). In conclusion, the Sarchimor genotype, combined with the natural and honey processing methods, showed a favourable balance between yield and cup quality, establishing itself as a viable alternative for producers seeking differentiated coffees.

Keywords: Granulometry, sieve, processing, Honey.

Resumen: El café es uno de los principales productos cultivados en la zona sur de Manabí. El objetivo del estudio es evaluar la productividad y las características organolépticas de cuatro genotipos de café arábigo (Sarchimor, Bourbon Rojo, Bourbon Amarillo y Catuai). Se empleó un diseño de bloques completos al azar (DBCA) con cinco repeticiones, se aplicó la prueba de Tukey al 5 % para identificar los tratamientos con mejor desempeño. En el análisis organoléptico se utilizaron tres métodos de beneficio por genotipo: natural, honey y lavado. En las variables productivas, los resultados

no expresaron diferencias estadísticas significativas entre tratamientos, aunque Sarchimor registró los mayores valores de productividad y Bourbon Amarillo los más bajos. En la granulometría, Sarchimor presentó mayores dimensiones en fruto maduro (largo: 14,08 mm; ancho: 14,02 mm; grosor: 11,96 mm). En café oro, no se observaron diferencias significativas, sin embargo, Sarchimor destacó con la mayor proporción en zaranda de 15 mm y un buen desempeño en flotación (5,90 %). En grados Brix, Bourbon Rojo obtuvo el mayor contenido de sacarosa (26,3), mientras que, en la clasificación de semillas, no se encontraron diferencias estadísticas. En cuanto al análisis organoléptico, los tratamientos Sarchimor natural y honey alcanzaron las mejores puntuaciones (82,5), mientras que Bourbon Rojo lavado obtuvo la calificación más baja (78,3). En conclusión, el genotipo Sarchimor, combinado con los métodos de beneficio natural y honey, mostró un equilibrio favorable entre rendimiento y calidad en taza, consolidándose como una alternativa viable para productores que buscan cafés diferenciados.

Palabras clave: Granulometría, zaranda, beneficio, Honey.

Introduction

Ecuador ranks fourth in South America in coffee production, making it one of the most representative industries at the national level (Ortega, 2024). It exports coffee varieties such as washed Arabica and natural Arabica (Yosa & Regalado, 2021). However, in recent years, it has experienced ups and downs with variations of 50%, evidencing comprehensive problems (Jadan et al., 2024). Specifically, in the Jipijapa canton, it has been in a critical situation in recent years due to low productivity and poor quality of export beans, due to the prevalence of old and unproductive coffee plantations and the failure to adopt appropriate production and processing techniques (Merino et al., 2021).

Coffee is distinguished by its high productivity and sensory characteristics, which vary according to the area of origin (Jiménez et al., 2023). Additionally, the expansion of areas devoted to cultivation, the adoption of production systems, and the application of dry or traditional processing as the predominant method for obtaining green coffee demonstrate the sector's potential for the production and marketing of specialty coffees (Juárez González et al., 2021).

This study evaluates the productive behaviour and organoleptic characteristics of four Arabica coffee genotypes in Andil using three types of processing, in order to identify the balance between productivity and sensory quality, strengthening the competitiveness of

Ecuadorian coffee in specialised niche markets and generating higher incomes for small producers, thus promoting genotypes adapted to local conditions and aligned with international quality standards.

Methodology

The research was carried out at the Experimental Unit of the Faculty of Natural Sciences and Agriculture belonging to the State University of Southern Manabí, located in Andil, 5 kilometres from the road leading to the parish of Noboa in the canton of 24 de Mayo, at an altitude of 378 metres above sea level; with georeferencing 17M 0551229 and UTM 9851068 (National Secretariat of Planning and Development, 2023).

Treatments

In the production area, four treatments were proposed, these being the genotypes: Sarchimor, Red Bourbon, Yellow Bourbon and Catuai.

Specific management of the research

The experiment was carried out between June and September 2024. Harvesting was done manually, two to three times a week, selecting only fruits in optimal ripeness. Each sample was identified with a unique code and stored in individually labelled bags. The production of each plant was weighed in grams using a Camry precision digital scale (1 g – 5 kg).

Production characteristics

To determine productivity per treatment, production per plant was considered, defining the average per repetition and treatment. Subsamples consisting of 100 ripe fruits were then taken, recording the corresponding weight at the different stages of processing: ripe fruit, pulped, dry parchment and green coffee.

Physical characteristics of the fruit and bean

The grain size was evaluated from five samples of ripe fruit per treatment (taken at random), processed using wet processing. The physical dimensions (length, width and thickness) of the ripe fruit were

measured. With regard to the grain size of the seed, samples of coffee in the green coffee state with 11% moisture content were taken. The measurements were taken with a stainless steel digital Vernier caliper (accuracy ± 0.01 mm).

The pulping process was carried out immediately after each harvest using a mechanical pulper. Subsequently, the soluble solids content ($^{\circ}$ Brix) was determined using a portable ATC refractometer (range 0–32%), using the mucilage extracted from randomly selected ripe fruits.

For the flotation test, 200 fruits per genotype were placed in a container with clean water and the floating grains were removed with a sieve in order to estimate the proportion of low-density fruits.

Post-harvest processing was carried out under three treatments:

Honey: the beans were dried with part of the mucilage attached until they reached 11% moisture content (Alomia & Untiveros 2021)

Washing: the pulped beans were washed with water to completely remove the mucilage, following the method described by Muñoz (2022).

Natural: the whole fruits were sun-dried in shelters, as indicated by Cañarte et al. (2021).

All treatments were dried in guadua cane shelters (5 m \times 1 m) with three levels of 5 mm (B05/120) polyethylene mesh and a transparent polypropylene top cover. Checks were also carried out every three days with a digital moisture meter (Amtast GM006), keeping the grains within the optimal range of 10–12%. According to Leroy et al. (2006), values above 12.5% predispose the development of mould, while values below 8% cause loss of flavour.

Once drying was complete, the physical quality of the grain was assessed based on 200 seeds per sample, classified according to their morphology (normal, snail-shaped, triangular or deformed). The seeds were stored for one month in labelled paper bags to stabilise their moisture content before threshing, which was carried out at the Federation of Peasant Organisations of the Southern Zone of Manabí (FOCAZUM).

The threshed grain was classified using manual sieves of 15, 14, 13 mm and base, obtaining the proportions by size. From each treatment, 350 g of grain were extracted and weighed on a STEP Systems GmbH electronic balance (capacity 500 g).

The samples were coded and sent to Laboratorio de Solubles Instantáneos C.A. (Guayaquil), where sensory evaluation was carried out under the Specialty Coffee Association (SCA) protocol. The organoleptic analysis was performed by José Miguel Mosquera, including roasting and standardised tasting of the samples.

Statistical analysis

Within the production guidelines, a completely randomised block design was applied using analysis of variance (ANOVA) and comparison of means with Tukey's test at 5% significance, while for the evaluation of qualitative variables, a descriptive analysis was applied, considering a total of 12 combinations resulting from the interaction between four genotypes (Sarchimor, Bourbon Rojo, Bourbon Amarillo and Catuai) and three types of processing (wet, natural and honey).

Results

Analysis of productive variables

The data were verified in order to check compliance with the normality assumption, an essential requirement for ANOVA. The results of the normality test showed that the data did not follow a normal distribution, so they were transformed using the square root to comply with this assumption.

Table 1. ANOVA and comparison of means of production variables

Variables	T1 (Sarchimor)	T2 (Red Bourbon)	T3 (Yellow Bourbon)	T4 (Catuai)	P value
Total cherry production per plant	850.15± 3.63 (8.14)	646.2± 2.54 (7.05)	425.25± 2.46 (7.90)	646.2± 2.61 (7.03)	0.33 ^{NS}
Cherry production per hectare	83.96± 5.1 (8.14)	63.81± 0.8 (7.05)	42.01± 0.77 (7.9)	68.05± 0.82 (7.03)	0.2386 ^{NS}
Yield per quintal of parchment	16.8± 2.28 (8.13)	12.77± 0.36 (7.05)	8.4± 0.35 (7.90)	13.6± 0.37 (7.03)	0.2381 ^{NS}

Yield per quintal of green coffee.	12.6± 1.97 (7.05)	9.56± 0.31 (7,05)	6.3± 0.3 (7.89)	10.21± 0.32 (7.03)	0.2374 ^{NS}
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The Sarchimor (T1) genotype had the highest values for all production variables, with a total cherry yield per plant of 850.15 g (83.96 qq/ha), a parchment yield of 16.8 qq/ha and a green coffee yield of 12.6 qq/ha. In contrast, Bourbon Amarillo (T3) recorded the lowest values, with 425.25 g per plant, 42.01 qq/ha, 8.4 qq/ha of parchment and 6.3 qq/ha of green coffee. The Bourbon Rojo (T2) and Catuai (T4) genotypes showed intermediate yields and similar performance, with productions close to 646 g per plant and yields of 63.81 and 68.05 qq/ha, respectively.

Although numerical differences were observed between genotypes, these were not statistically significant ($p>0.05$) in any of the variables analysed, suggesting comparable productive behaviour under the trial conditions.

These results differ partially from those reported by Álvarez (2025), who found that Sarchimor ranked third with a yield of 599.6 g per plant and 43.75 qq/ha, but they coincide in the trend that shows good productive performance of this genotype. On the other hand, Valencia (2020) points out that under homogeneous agroecological conditions, differences between genotypes can be attenuated due to management, which would explain the absence of significant differences in this research, despite the fact that Sarchimor presented higher values, as demonstrated in our study and in that of Córdova et al. (2025), who reaffirms that this genotype was created with the purpose of optimising productivity and strengthening the crop's resistance to adverse conditions, particularly in the dry areas of Ecuador.

According to García et al. (2025), the relationship between cultivated area and parchment coffee yield is not always directly proportional, since agronomic management can become less efficient on larger areas, affecting productivity. This shows that yield optimisation depends more on technical management and space utilisation than on plantation size. Similarly, Muñoz et al. (2021) emphasise that the analysis of yield components is fundamental for agricultural planning, as it allows for the anticipation of production and the orientation of management strategies that improve productive efficiency.

Analysis of physical variables

Table 2. ANOVA and evaluation of means of physical characteristics of the fruit.

Variable (Unit of measurement mm)	T1 (Sarchimor)	T2 (Bourbon Red)	T3 (Yellow Bourbon)	T4 (Catuai)	P value
Long Mature fruit	14.08±0,28 th (4.51)	13.42± 0.27 ^a (4.53)	12.48±0,34 ^a (6.14)	12.86± 0.58a (10.09)	0.05*
Mature fruit width	14.02±0,07 ^a (1.06)	13.34± 0.46 ^{ab} (7.71)	11.85±0,48 ^b (9.13)	12.59± 0.39 ^{ab} (6.94)	0.01*
Thickness of ripe fruit	11.96±0,27 ^a (5)	11.32± 0.26 ^{ab} (5.17)	10.39± 0.39 ^b (8.37)	11.11± 0.33 ^{ab} (6.6)	0.02*
Long black coffee	8.61± 0.3^a (7.67)	9.05±0, 18 ^a (4.34)	9.12±0, 28 ^a (6.82)	8.72± 0.27^a (6.86)	0.50
Gold coffee width	6.86± 0.23a (7.64)	6.9±0,41 ^a (13.31)	6.08± 0.65 ^a (24.08)	6.64± 0.18 (5.98)	0.56
Coffee thickness Gold	3.69± 0.11a (6.69)	3.36±0,17 ^a (11.3)	4.24± 0.41 ^a (21.46)	3.6± 0.18a (11.98)	0.10
Sucrose measurement	23.78± 0,69 to (6.46)	26.3± 1.14 ^{ab} (9.69)	21.03± 0.83 ^c (8.8)	23.54±0,24 ^{ab} (2.32)	0.002**
Flotation test	5.90±0,89 (5.79)	3± 0.42 ^b (5.58)	4± 0.63 ^{ab} (5.95)	3± 0.42 ^b (5.58)	0.02**
Seed classification					
Snail	8.6± 0.53 ^a (13.88)	9± 1.24a (5.53)	8.4± 1.32a (7.25)	5.6± 1.1a (5.41)	0.10
Triangle	2± 0.5 ^a (7.47)	1.7± 0.54a (7.12)	0.8± 0.34a (6.69)	2± 0.65a (6.55)	0.2
Deformed	1.8± 0.6 ^a (6.71)	1.2± 0.25a (6.89)	0.7± 0.25 ^a (6.44)	1.1± 0.43 ^a (6.89)	0.3

Note. **: There is a statistically significant difference $P < 0.05$

abc: Differentiation of comparison of means.

In terms of ripe fruit dimensions, the Sarchimor genotype had the highest values for length (14.08 mm), width (14.02 mm) and thickness (11.96 mm), with significant differences ($P < 0.05$) compared to the other treatments. These results suggest that this genotype has a more developed and consistent fruit morphology, which may be associated with better grain filling and greater yield potential. In contrast, Bourbon

Amarillo had the lowest values for these variables: length (12.48 mm), width (11.85 mm) and thickness (10.39 mm), reflecting more limited morphological development.

In the variables corresponding to the green coffee bean, no statistically significant differences ($P < 0.05$) were observed in length, width, and thickness, although there was a slight tendency for greater thickness in Bourbon Amarillo (4.24 mm). This behaviour confirms that, despite morphological differences in the fruit, the size of the green bean tends to remain stable between genotypes, possibly due to the handling conditions during the processing phase.

With regard to sucrose measurement, highly significant differences were recorded ($P = 0.002$), with Bourbon Rojo achieving the highest value (26.3), followed by Sarchimor (23.78). This parameter is considered relevant, as a higher sucrose content is related to better sensory quality in the cup, contributing sweetness and balance to the organoleptic profile of the coffee. In contrast, Bourbon Amarillo recorded the lowest value (21.03), which could negatively influence the perception of sweetness in the bean.

In the flotation test, significant differences were also observed ($P = 0.02$), with Sarchimor (5.90) again standing out with the highest bean density, indicating a lower proportion of empty or defective beans and, therefore, better physical quality. In comparison, the Bourbon Rojo and Catuai genotypes had the lowest values (3.0), showing lower bean density and structural quality.

Finally, seed classification showed no significant differences ($P < 0.05$) between treatments. However, Bourbon Rojo showed a slight tendency towards a higher percentage of snail-type seeds (9%), while Sarchimor and Catuai showed more balanced proportions.

According to Vidal et al. (2023), their study observed marked differences in the UNACAF-172 (Bourbon Rojo) and UNACAF-146 (Villa Sarchí) accessions, which presented higher values in polar, arithmetic and geometric diameter. These results are consistent with those obtained in the present study, where the Sarchimor genotype, derived from Villa Sarchí, stood out for its better physical attributes. However, Guevara (2023) offers a different perspective, pointing out that although bean size influences the physical quality of coffee, this parameter alone is not a determining criterion of quality.

Table 3. Description of grain size by treatment

Classification by sieve		Sieve 15 g % (Large)	14 g sieve %(Medium)	Sieve 13 g %(Small)	Base g % (Residue)
WASHING	Sarchimor	95.3	3.2	1.1	0.4
	Red Bourbon	91.5	6.0	2.3	0.3
	Yellow Bourbon	90.3	6.2	2.6	0.9
	Catuai	90.3	7.3	2.1	0.3
HONEY	Sarchimor	94.9	3.3	1.4	0.4
	Red Bourbon	93.1	4.7	2.1	0.2
	Yellow Bourbon	86.6	9.6	3.4	0.4
	Catuai	93.1	6.4	0.5	0.0
NATURAL	Sarchimor	91.0	6.1	2.8	0.3
	Red Bourbon	94.1	4.3	1.3	0.3
	Yellow Bourbon	88.0	8.2	3.3	0.4
	Catuai	86.1	9.0	4.1	0.9

Table 3 shows the particle size distribution of the four Arabica coffee genotypes evaluated under three processing methods (washed, honey and natural), based on classification by sieves of sizes 15, 14, 13 and base. In all treatments, the highest percentage weight of beans was concentrated in the 15 sieve, reflecting a tendency towards obtaining larger beans. Within this parameter, Sarchimor consistently stood out as the treatment with the best retention in the 15 sieve, reaching 95.3% in washed, 94.9% in honey and 91.0% in natural. This behaviour suggests greater uniformity and larger bean size associated with this genotype.

In contrast, the Bourbon Amarillo and Catuai genotypes showed a higher proportion of beans classified in screens 14 and 13, especially under the honey and natural methods, which shows greater grain size variability and the presence of smaller sizes in these treatments. despite what has been described in all cases, the percentage of beans retained at the base was low (<1%), which is a positive indicator of quality, as it represents a minimal presence of defective or non-commercial size beans.

These results are in line with those reported by Herrera et al. (2023), who establish that, in order to meet commercial quality standards, coffee must have at least 50% by weight of beans larger than screen 15 and less than 5% smaller than screen 14. In this regard, the Sarchimor treatment far exceeds these requirements in the three processing

methods evaluated. Buendía et al. (2020) indicate that American consumers prefer coffee beans between screens 15 and 16, while Europeans prefer them between screens 17 and 18, highlighting that bean size influences the physical quality of coffee, although it is not a sufficient quality criterion.

Table 4. Description of organoleptic variables

TREATMENTS	Natural red Bourbon	Red honey Bourbon	Red washed Bourbon	Natural yellow Bourbon	Yellow honey Bourbon	Washed yellow Bourbon	Natural Sarchimor	Sarchimor honey	Washed Sarchimor	Natural Catuai	Catuai honey	Catuai washed
Aroma	7.5	7	6.75	7.25	7.5	7.5	7.5	7.75	7	7.5	7.5	7
Flavour	7.25	7.25	7	7.25	7.25	7.25	7.5	7.5	7.25	7.5	7.5	7.5
Aftertaste	7.5	7.25	7	7.25	7.5	7.25	7.5	7.5	7	7.25	7.25	7.25
Acidity/salt	7.25	7.25	6.75	7.25	7	7.25	7.5	7.5	7	7.25	7.5	7.25
Body	7.5	7.5	7	7.5	7.25	7.5	7.5	7.25	7.25	7.5	7.25	7.25
Balance	7.5	7.25	7	7.25	7.25	7.25	7.5	7.5	7	7.5	7.25	7.25
Sweetness	10	10	10	10	10	10	10	10	10	10	10	10
Clean cup	10	10	10	10	10	10	10	10	10	10	10	10
Uniformity	10	10	10	10	10	10	10	10	10	10	10	10
Taster score	7.5	7.25	6.75	7.25	7.25	7.5	7.5	7.5	7	7.5	7.25	7.25
Defects	0	0	0	0	0	0	0	0	0	0	0	0
Total	82	80.8	78.3	81	81	81.5	82.5	82.5	79.5	82	81.5	80.8

Table 4 describes the organoleptic attributes evaluated in the different coffee genotypes (Red Bourbon, Yellow Bourbon, Sarchimor, and Catuai) subjected to natural, honey, and washed processing methods.

The results indicate that the Sarchimor natural and Sarchimor honey treatments performed best in terms of sensory characteristics, achieving the highest total scores (82.5 points) and falling within the speciality coffee classification according to the criteria established by the SCAA (2018), with both treatments obtaining maximum scores (10 points) for sweetness, clean cup and uniformity, as well as showing higher values for aroma, flavour, body and acidity/salt than the other treatments.

In a second quality level were Catuai natural (82 points) and Bourbon Rojo natural (82 points), which also maintained consistent sensory profiles without defects. In contrast, the Bourbon Rojo washed treatment obtained the lowest total score (78.3 points), mainly related to observable reductions in attributes such as aroma (6.75), flavour (7.0) and acidity/saltiness (6.75).

The most relevant organoleptic characteristics in specialty coffees—fragrance, aroma, acidity, flavour and body—were highlighted in most of the treatments evaluated, as reported by Mendoza et al. (2023), reaffirming the good commercial potential of the genotypes studied.

Julca et al. (2023) point out that the Bourbon genotype is characterised by offering a high-quality beverage. However, the results obtained in this study do not coincide with this reference, as Bourbon scored lower in the organoleptic evaluation compared to other genotypes.

The results are consistent with those reported by Maldonado et al. (2024), who reported an organoleptic score of 82 points for the Catuai genotype, a value very close to that obtained in this study (81.5 points), showing that, although no statistically significant differences were determined between cultivars, the variations in the final score are important in the differentiated coffee market.

Recent literature reports that coffees processed with controlled fermentation can achieve higher organoleptic scores (87–88 points) and more complex sensory profiles, as evidenced in the Bourbon and Geisha varieties (Payehuanca, 2024). although these results exceed those obtained in the present study, they constitute a benchmark for optimising post-harvest management, considering that 60% of cup quality depends on processing and only 40% on agricultural production Vidal et al., (2023).

Conclusions

The joint evaluation of productivity, physical characteristics of the bean, and sensory quality shows that, although there are no significant differences in yield between the genotypes studied, there are distinctive physical and sensory attributes, particularly in Sarchimor and in the natural and honey processing methods, which reflect a relevant qualitative differentiation.

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