


ORIGINAL ARTICLE

Consumers' perception of different brewed coffee extractions using the sorting technique

Juliana Lustosa Ferini  | Michele Veiga Morales | Thaís Araújo da Silva |
Juliana Rocha Mendes Pedreira | Nathália Tiyo de Godoy | Aline de Oliveira Garcia |
Sílvia Amélia Verdiani Tfouni

Food Science and Quality Center, Institute of Food Technology (Ital), Campinas, SP, Brazil

Correspondence

Juliana Lustosa Ferini, Food Science and Quality Center, Institute of Food Technology (Ital), Av. Brasil, 2880, Jd. Chapadão, 13070-178, Campinas, SP, Brazil.
Email: juliana.ferini@ital.sp.gov.br

Funding information

Agribusiness Research and Development Foundation; Conselho Nacional de Desenvolvimento Científico e Tecnológico; Brazilian National Council for Scientific and Technological Development

Abstract

This study investigated coffee brewing methods from the consumer perspective using the sorting task. The hypothesis was that consumers consider espresso and coffee capsule beverages to be the result of similar extractions. In the first assessment, the following ten extraction methods were studied: paper filter, cloth strainer, Italian coffee maker, French press, electric coffee maker, espresso, and four capsule coffee machines, and 36 assessors conceptually sorted them into groups. In the second assessment, two espresso and eight capsule coffee samples were evaluated. One hundred and eighteen assessors tasted the samples and sorted them into groups according to their sensory similarity. They also evaluated each group for their acceptability and quality and characterized them by the check-all-that-apply (CATA) method. The results showed that when conceptually evaluating the different brewing methods, the consumers considered espresso and capsule coffees to be alike, but when they tasted the different espresso and capsule coffees, they perceived them as different beverages. Therefore, the sorting task is suitable for measuring how the consumers perceive similarities and differences among different brewed coffees, and was improved by association with the CATA analysis.

Practical Applications

Coffee capsules are gaining markets worldwide, so this study investigated whether capsule coffee is similar to espresso coffee from the consumer point of view. To analyze this question, the sorting method was applied in an innovative way evaluating the perception of the different coffee extraction methods by presenting videos, photos and the coffee machines and devices themselves. Subsequently, sorting was applied to evaluate the actual beverages. When conceptually evaluating the different brewing methods, the consumers grouped espresso and capsule coffees together, but they perceived differences in the sensory characteristics when they tasted the samples. Thus, marketing companies will be able to use the findings of this research to better communicate with consumers.

1 | INTRODUCTION

Coffee is one of the beverages most consumed throughout the world due to the sensations produced by its complex composition of aromas and flavors. Furthermore, the phenolic

compounds present in coffee beans have antioxidant properties, showing health benefits attributable to their reducing-oxidizing properties and chelating activities, that act on free radicals and prevent transition metals acting as oxidation promoters (Abraão et al., 2010).

These flavor compounds depend on the whole process that the coffee is submitted to from seed to table. Partida-Sedas, Muñoz Ferreiro, Vázquez-Odériz, Romero-Rodríguez, & Pérez-Portilla, 2019, evaluated the “natural,” “depulping,” “fermenting,” and “washing” processes of green coffee by quantitative evaluations with expert cuppers and hedonistic analyses with consumers. The results showed similar sensory characteristics and general acceptances, although the acceptance map obtained from a multiple factor analysis showed that the “depulping” process could replace the “washed” coffee process (Partida-Sedas et al., 2019).

The Brazilian coffee quality program (PQC), introduced by the Brazilian Coffee Industry Association (ABIC), allows for the classification of coffee beverages by a sensory evaluation of their aromas and flavors carried out by a trained panel in accredited laboratories. According to an overall quality scale, the brewed coffee is classified as: Traditional, with an average score between 4.5 and 5.6; Superior, with an average score between 6.0 and 7.2; and Gourmet, with an average score above 7.3 (Associação Brasileira da Indústria do Café–ABIC, 2019).

A controlled procedure is required to prepare the coffee, as this step is responsible for the production of a high-quality coffee beverage. The preparation consists of extracting the flavor and aroma from the roasted and ground coffee using hot water, but there are cultural variants that determine different preparation processes, although these should follow some basic rules to obtain a good beverage. The addition of hot water to roasted and ground coffee is a process known as infusion, and can be carried out by filtration, percolation, pressing or pressure (also known as espresso), thus obtaining different sensory characteristics with respect to the aromas, flavors and body of the beverages (Associação Brasileira da Indústria do Café–ABIC, 2017).

The coffee capsule system, as an innovative product, has gained popularity mainly due to its practicality. According to the Euromonitor International report, the use of Brazilian coffee capsules represented 0.9% of the total coffee consumption in 2017, with a projection of reaching 1.1% by 2021. Despite being a small percentage, coffee capsules have a high added value with important dissemination throughout the country (Euromonitor International, 2017; Parenti, Guerrini, Masella, Spinelli, & Calamai, 2014).

Qualitative research is often used to develop and clarify a hypothesis in product development, since it allows for quick, inexpensive probing of consumer demands in a natural and comfortable environment. In addition, it can also be used as a substitute for classical quantitative profiling methods or to powerfully increase the impact of quantitative methodology. Furthermore, qualitative research methods offer insights into consumer opinions, and allow one to read consumer thoughts concerning the concept of the product, which is a dimension not reached by quantitative methods (Jervis & Drake, 2014).

Various sensory qualitative evaluation methods have been used to understand consumer preferences and optimize products, including the Check All That Apply (CATA) and Sorting methods. CATA is a widely used method consisting of a list of attributes to describe the product under study, and the consumers can select those they

consider more appropriate to describe the product (Valentin, Chollet, Lelievre, & Abdi, 2012). The sorting method consists of a data collection procedure, in which the assessors sort the samples into groups based on the similarities and differences between the samples. Sorting is based on free categorization and aims to present the spatial structure of each product, as well as the interpretation of underlying dimensions. The sorting matrix is analyzed by multidimensional scaling (MDS), which is used to visualize the distances between objects in a small dimensional space. In MDS, each object is represented by a point on the map, distributed in such a way that objects located close to each other are perceived as being similar, while objects perceived as different are located far from each other (Chollet, Valentin, & Abdi, 2014).

Cartier et al. (2006) investigated the efficiency of sorting methods as an alternative to the quantitative descriptive analysis to obtain a sensory map of foods. The authors investigated whether sorting with a trained panel would have similar results when compared to quantitative descriptive analysis and the results showed that the sorting method combined with verbalization led to a significant and consistent sensory mapping of the product, regardless of the level of training of the assessors (Cartier et al., 2006).

It could be hypothesized that, in the consumer's mind, capsule coffee is similar to espresso coffee as compared to the other brewing methods, since both beverages are extracted by machines and in the cup they look similar. Therefore, the aim of the present study was to conceptually investigate, via the sorting method, the coffee beverages obtained using the various extraction methods.

Having confirmed this first hypothesis, that is, that the capsule coffee beverages clustered with the espresso coffee beverages on a visual analysis of the different coffee extraction methods, a second hypothesis considered whether the tastes of the beverages obtained from coffee capsules were similar to those obtained from espresso brewing. Finally, how consumers sorted ten samples of capsule and espresso brewed coffee beverages was investigated.

2 | MATERIALS AND METHODS

2.1 | MATERIAL

For the first assessment, ten different coffee extraction machines or devices were used, namely paper filters #102 and #103 (Melitta), cloth strainer (Esperança), 400 ml Italian coffee maker (Junior Express), 250 ml French-press coffee maker (Tramontina Coffee & Tea), 700 ml electric coffee maker (Brastemp 12 cups Compact Coffee Maker) with #102 coffee paper filter, espresso coffee machine (La Spaziale Mini Vivaldi S1) with a set-up for preparing two cups simultaneously and four brands of capsule coffee machines (Nespresso Inissia, Três Corações Modo S04, Dolce Gusto Automatic Mini Me and Illy Francis Francis Y1).

For the second assessment, ten coffee beverage samples were served: Superior roasted and ground coffee, Gourmet roasted coffee for espresso beverage and 2 coffee capsules from each brand. Each

coffee capsule brand was previously evaluated by a trained team for its overall quality classification according to the Coffee Quality Program (PQC) of the Brazilian Coffee Industry Association (ABIC). The capsule samples were coded with letters A, B, C and D, according to their brands and number 1 and 2 according to their overall quality, representing the designations of Gourmet and Superior, respectively (ABIC, 2019). The main differences between these two qualities are that Gourmet samples are sweeter, more acid, fruity and full bodied, and also less astringent and less bitter than Superior samples.

2.2 | METHODS

2.2.1 | Preparation of brewed coffee

For the first assessment, the devices were displayed on a table side by side, and the photo of the extracted beverage was displayed in front of each device. Short recorded videos of each preparation method were also shown to the assessors as they carried out the evaluation.

Paper filter

A plastic coffee filter holder and a #103 coffee paper filter were used for the extraction. The brewed coffee was prepared using 50 g of roasted and ground coffee and 500 ml of Bioleve mineral water at 92–96°C.

Cloth strainer

The extraction was done directly through the cloth strainer, using 50 g of roasted and ground coffee and 500 ml of Bioleve mineral water at 92–96°C.

Italian coffee maker

The brewed coffee was prepared using 40 g of roasted and ground coffee, which was placed in the metal container of the Italian coffee maker, and 400 ml of Bioleve mineral water. The coffee maker was allowed to boil until the beverage was obtained.

French pressing

The brewed coffee was prepared using 25 g of roasted and ground coffee, which was placed inside the French press reservoir, and 250 ml of Bioleve mineral water at 92–96°C, followed by manual stirring for 2 minutes. The lid was then placed on the French press and the plunger pushed down about 2 cm, where it was maintained for 30 seconds, and then slowly pushed down to prevent the coffee powder from remaining in contact with the liquid phase of the beverage.

Electric coffee maker

The extraction was done using 50 g of roasted and ground coffee placed in a #102 coffee paper filter and 500 ml of Bioleve mineral water, which was placed in the electric coffee maker reservoir for brewing.

Espresso coffee machine

The procedure was carried out according to the manufacturer's instructions. Gourmet roasted coffee (ground at the time of preparation) and Superior roasted and ground coffee were used.

Capsule coffee machines

Four capsule coffee machines were used. The extraction was done in the respective capsule coffee machine according to the manufacturer's instructions.

2.2.2 | Analyses

Sorting of coffees obtained by different brewing methods

The first assessment was carried out with 36 volunteers, who consumed and prepared coffee at least once a week, 24 being female and 12 male, aged between 18 and 60 years, belonging to social classes A, B, and C, according to the Brazil Criteria of Economic Classification (ABEP, 2018).

In a room with fluorescent light, the ten different coffee brewing machines or devices were displayed side by side as described in item 2.2.1. Each method received a three-digit code and was arranged for each evaluator in a randomized order.

The data were collected on paper sheets. The assessors were instructed to sort the ten brewing methods into groups according to the similarity and differences between them. They were also informed there was no minimum or maximum number of clusters, and no fixed number of brewing methods for each group, emphasizing that each brewing method could only be allocated to one group.

Each assessor was asked to complete a demographic questionnaire on coffee consumption and to fill out a free and informed consent form about their participation, which could be discontinued at any time according to the instructions of the Research Ethics Committee.

Sorting of the espresso and capsule coffees

118 espresso coffee consumers, aged from 18 to 65 years, belonging to social classes A, B and C, according to the Brazil Criteria of Economic Classification (ABEP, 2018), and with a monthly consumption of espresso or coffee capsules, were recruited to evaluate the 10 brewed coffees obtained by the conventional espresso method or using the capsule coffee machines. Each assessor was also asked to complete a demographic questionnaire on coffee consumption and to fill in a free and informed consent form about their participation, which could be discontinued at any time, according to the directions of the Research Ethics Committee.

Before the evaluation, the consumers were asked about their preferences for sugar, sweetener or pure non-sweetened coffee, where they could use 5 g of sugar per sample (before the extraction) or 5 drops of a sweetener composed of sodium saccharin and sodium cyclamate, as desired. Disposable stick stirrers were offered along with the samples to allow for a homogeneous mixture of coffee and sugar or sweetener. The test was carried out in booths equipped with

the Compusense Cloud system, under fluorescent illumination. The samples were coded with three-digit numbers and arranged for each consumer according to a balanced complete block design. All preparations were carried out to simulate household consumption, and hence the brew volumes prepared automatically by the machines and offered to the consumers, varied from 25 to 40 ml. In the case of machine D, an extraction time of 25 s was used. All the coffee beverage samples were extracted and served in 80 ml plastic cups at a temperature close to 70°C.

After tasting the samples, the consumers were asked to create at least two groups of samples but no more than five groups. Bioleve mineral water was offered along with the samples for palate cleansing.

After completing the first step, the consumers were asked to use a five-point scale (5 = very good /premium product, 3 = regular/standard product, 1 = very bad/low-quality product) to classify the quality of each group. They were also asked to evaluate the acceptability according to a nine-point hedonic scale (9 = liked extremely, 5 = neither liked nor disliked and 1 = disliked extremely).

Finally, the CATA descriptive analysis was applied to each group using a list of 26 attributes, and the consumers were asked to choose the descriptors that best characterized the products. To prepare the list of CATA descriptors, a focus group of 5 consumers discussed the subject to choose the least complex descriptors from the Coffee Tasters Flavor Wheel to represent the samples studied (Specialty Coffee Association—SCA, 2016). The attributes raised were: sweet, acid, bitter, astringent, nut/hazelnut, chocolate, weak, strong, characteristic coffee flavor, floral/fruity, smoke/tobacco, burnt, caramel, herb/tea, full-bodied, off-flavor, spice/black pepper/nutmeg, consistent crema, thin crema, no crema, creamy (mouthfeel), chemical/woody/medicinal, watery, foaming/large bubble crema, light crema, and dark crema.

2.2.3 | Statistical analysis

The sorting data were evaluated using a similarity matrix and multidimensional scaling (MDS). For the MDS, a Kruskal stress model was considered, with a dimensional space of 2 to 4, random start configuration with 5 repetitions, and using the convergence criterion of 0.00001 with a maximum number of iterations of 500. The ANOVA and Tukey's tests were used for the quality and hedonic scale data

($p < .05$) and for the CATA findings, Cochran's test was applied to each sensory descriptor based on their chi-square distances. All the analyses were carried out using the program XLSTAT, version 2016.03.35937.

3 | RESULTS AND DISCUSSION

3.1 | Sorting of different brewing methods

Figures 1 and 2 show the characteristics of the consumers with respect to age, frequency of coffee consumption, time of consumption and types of coffee consumed.

Figure 3 shows the sorting analysis for similarity. Different symbols were used on the scale as follows: full circle = very close (above 72%), 3/4 circle = moderately close (47 to 71%), 1/2 circle = not very close (22 to 46%), 1/4 circle = not very far (11 to 21%) and empty circle = very far (below 10%).

Figure 4 presents the multidimensional scaling analysis (MDS). In MDS, the greater the distance between two points, the greater the dissimilarity between them (Kruskal & Wish, 1978). According to Kruskal (1964), stress is a natural measure of adjustment, which measures how well any setting fits the data, and a setting with the least stress is desired. In this study, the data were well represented by two dimensions, since the Kruskal stress value was 0.145 (Kruskal, 1964).

In Figure 4, the ellipses show the clusters according to their similarity in Figure 3, to facilitate visualization of samples with greater similarity. The more well-known capsule coffee machines (A, B, and C) were grouped very close to each other, as were the cloth strainer and paper filter extractions. It can be seen that the capsule coffee machine D was located close to the other capsule coffee machines at a moderately close distance, as also the electric coffee maker was close to the cloth strainer and paper filter extractions, while the French press was close to Italian coffee maker. The Espresso coffee machine was rated as less close to the capsule coffee machines, and the Italian coffee maker was less close to the electric coffee maker, the cloth strainer and the paper filter extraction.

The characteristics defined for each group were distributed amongst the brewing methods. The consumers made a distinction between the extraction methods using a paper filter, cloth strainer,

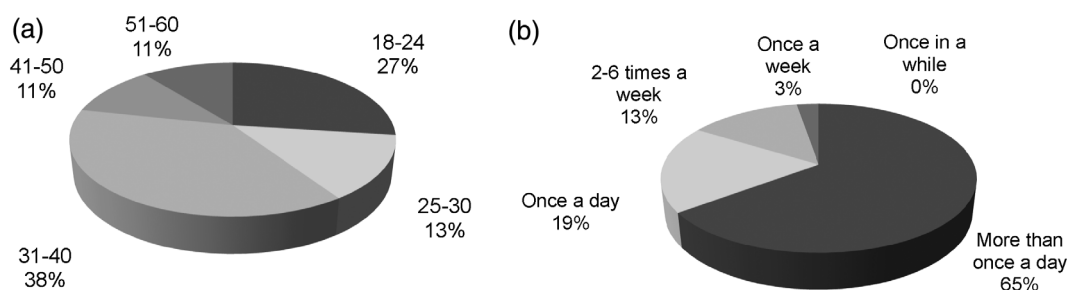


FIGURE 1 Age (a) and frequency of coffee consumption (b) as reported by the group of 36 consumers

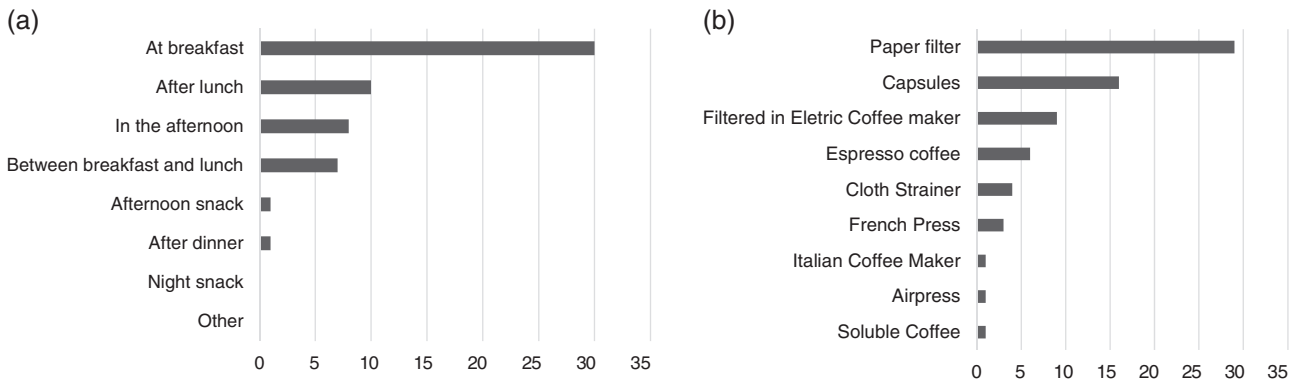


FIGURE 2 Moment of consumption (a) and types of coffee consumed (b) as reported by the group of 36 consumers

FIGURE 3 Sorting analysis for similarity of the brewing methods. The higher the percentage of citations, the closer the perception of similarity between samples by the group of 36 consumers

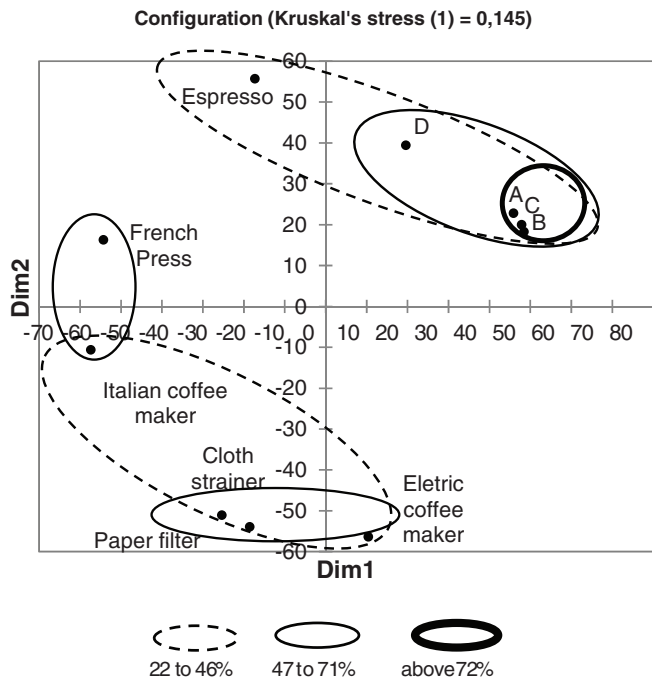
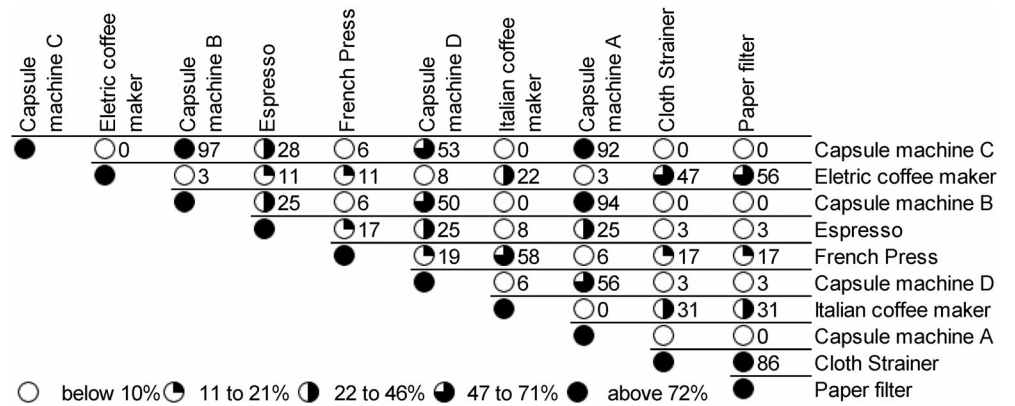


FIGURE 4 Multidimensional scaling (MDS) of the different brewing methods by the group of 36 consumers

French press, electric coffee maker and Italian coffee maker and the methods using espresso coffee and capsule coffee machines.

The paper filter, cloth strainer and electric coffee maker extractions, as also the French press and Italian coffee maker methods, were

considered simple, cheap, traditional, home-made but time-consuming extractions, besides allowing one to obtain large amounts of brewed coffee, except for the French press and Italian coffee maker, which were considered to be non-traditional by some consumers.

In turn, both the espresso and capsule coffee systems were considered to be expensive methods, and consumers associated the capsule coffee machines with ease of preparation, practicality, speed and modernity, which justified the added value of the extraction method.

Even though the assessors did not taste the samples, they assumed the beverages extracted using the capsule coffee and espresso coffee machines would be characterized as strong, full-bodied and espresso-like beverages. The beverage prepared by the French press method was also characterized by the descriptors of creamy, strong and full-bodied but the coffees brewed using paper filters or cloth strainer extractions were described as mild and weak.

3.2 | Sorting of espresso and coffee capsule coffees

Figure 5 shows the characteristics of the group of 118 consumers who took part in the second step of the study for the evaluation of 10 brewed coffee samples extracted using the conventional espresso and capsule coffee machines.

Figure 6 shows the similarity matrix. To facilitate data visualization, different symbols were used on the scale, as follows: full circle = very close (above 32%), 3/4 circle = moderately close

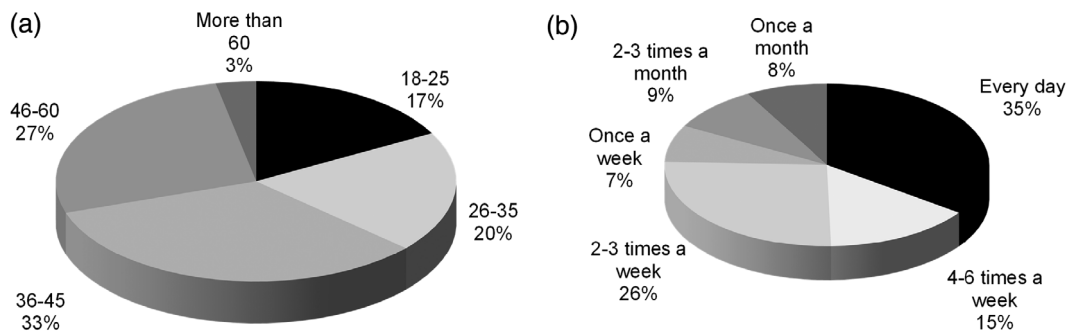


FIGURE 5 Age (a) and frequency of consumption of espresso or capsule coffees (b) as reported by the group of 118 consumers

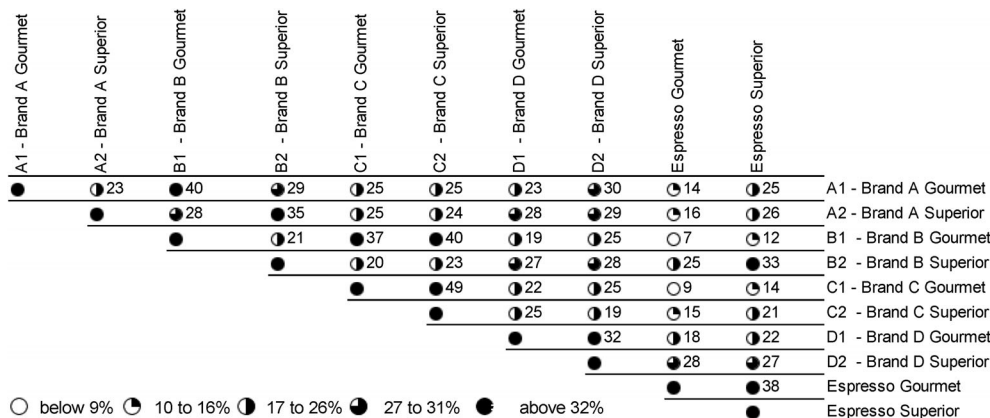


FIGURE 6 Sorting analysis of the espresso and capsule coffee samples for similarity. The higher the percentage of citations, the closer the perception of similarity between samples by the group of 118 consumers

(27–31%), 1/2 circle = not very close (17–26%), 1/4 circle = not very far (10–16%) and empty circle = very far (below 9%).

Figure 7 presents the multidimensional scaling analysis (MDS) which sorted the samples into groups: B1, C1 and C2 (Group T); B1 and A1 (Group V); D1 and D2 (Group W); Superior espresso and Gourmet espresso (Group X); Superior espresso and B2 (Group Y); and A2 and B2 (Group Z). These groups were highlighted by ellipses according to the results in Figure 6.

As shown in Figure 7, the Kruskal stress value was 0.284, which is considered to be a high value, that is, the graph did not explain the data very well. The high Kruskal stress values in the sorting data may be due to the use of different criteria to cluster the samples, as well as to the fact that the coffee samples in different groups showed similar characteristics. For example, samples B2 and D2, both characterized by CATA as strong, were sorted into distinct groups (Z, Y, and W).

The CATA analysis was carried out with 26 descriptors, of which 12 explained the differences between the samples well, according to the characteristics shown in Table 1. The Correspondence Analysis of the CATA data in Figure 8 clearly explained the sample characterization, with an explanation of 88%. Giacalone et al. (2018) also obtained a high explain variance, 94%, on Correspondence Analysis performed on CATA, generating a sensory space that clearly explained the differences among the samples (Giacalone et al., 2018).

According to Table 1, significant differences ($p < .05$) were found between 12 of the 26 espresso coffee descriptors. The attributes of sweet, astringent, nuts/hazelnut, chocolate, floral/fruity, smoke/

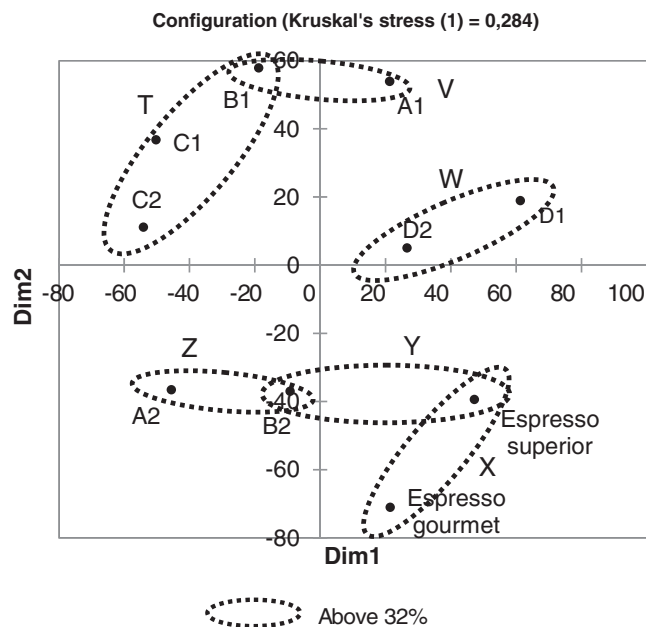


FIGURE 7 Multidimensional scaling (MDS) of the espresso and capsule coffee samples by the group of 118 consumers

tobacco, caramel, herb/tea, spice/black pepper/nutmeg, thin crema, watery, foaming/large bubble crema and light crema did not exhibit high citation frequency, and did not discriminate the samples, thus they were not considered. In a study with wines, Alencar et al. (2019)

used a list of 17 attributes and found significant differences ($p < .05$) between 7 of them (Alencar et al., 2019). In the same way, Vidal, Barreiro, Gómez, Ares, and Giménez (2013) used a list of 21 terms in a

study of milk desserts, and significant differences were found for 18 of these terms in the blind evaluation (Vidal et al., 2013).

As can be seen in Table 1 and Figure 8, the samples A1, B1, C1 and C2 were characterized by the attributes weak, consistent crema, creamy, characteristic coffee flavor and full-bodied. The sample A2 was characterized by the attributes of characteristic flavor, full-bodied and strong flavor. The samples D2 and B2 were characterized by the attributes of strong, bitter and burnt. The sample D1 was characterized by the descriptors strong, bitter, burnt, and off-flavor. The Superior espresso was characterized by the descriptor no crema and both the Superior and Gourmet espresso brews were characterized by the descriptors chemical/woody/medicinal, acid and off-flavor.

According to Vidal et al. (2013), care must be taken when using CATA questions to identify consumer vocabulary, since customers select terms to describe the products they might not spontaneously use in their everyday life (Vidal et al., 2013). On the other hand, Godoy, Veneziano, da Cunha Rodrigues, Schoffen Enke, and Lapa-Guimarães (2019) studied the sensory quality of the flathead gray mullet using the Word Association and CATA methods, and found that CATA provided a better discrimination between fish with different ice storage periods. Appropriate terms for the degree of freshness of fish were elicited using WA and checked using CATA, indicating that the untrained assessors were able to recognize the quality characteristics of the fish (Godoy et al., 2019).

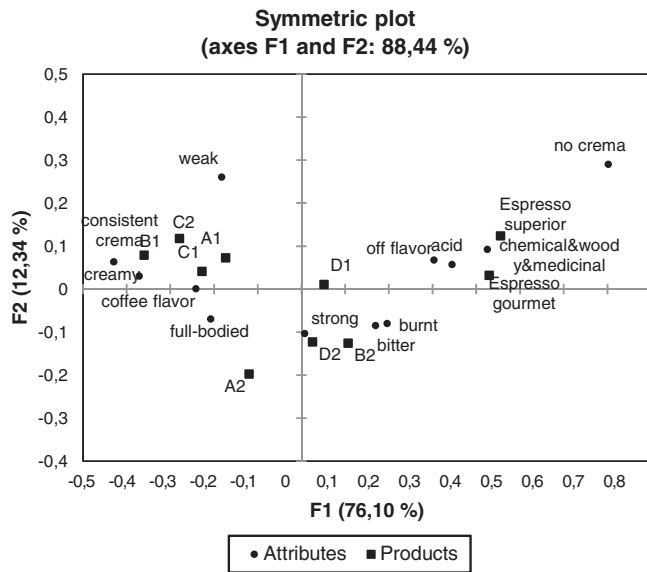


FIGURE 8 Correspondence analysis map of the CATA descriptors for the espresso and capsule coffee samples according to the group of 118 consumers

TABLE 1 Frequency attributes of CATA analysis of espresso and capsule coffee samples

Attributes	Samples									
	C2 Brand C Superior ^a	C1 Brand C Gourmet ^a	B1 Brand B Gourmet ^a	A1 Brand A Gourmet ^a	D1 Brand D Gourmet ^a	D2 Brand D Superior ^a	Superior espresso	Gourmet espresso	B2 Brand B Superior	A2 Brand A Superior
Acid	10.2 a	11.9 a	10.2 a	10.2 a	11.9 a	14.4 a	20.3 ab	32.2 b	18.6 ab	11.0 a
Bitter	24.6 a	26.3 abc	22.0 a	25.4 ab	42.4 c	33.9 abc	43.2 c	41.5 bc	41.5 bc	36.4 abc
Weak	26.3 b	22.0 ab	24.6 b	22.9 ab	15.3 ab	21.2 ab	18.6 ab	13.6 ab	12.7 ab	9.3 a
Strong	33.1 a	35.6 a	34.7 a	38.1 ab	40.7 ab	38.1 ab	36.4 a	40.7 ab	55.1 b	48.3 ab
Burnt	16.1 abc	18.6 abc	11.0 a	16.1 ab	28.8 bc	23.7 abc	30.5 c	26.3 abc	25.4 abc	23.7 abc
Characteristic coffee flavor	35.6 b	32.2 ab	37.3 b	31.4 ab	29.7 ab	25.4 ab	19.5 a	17.8 a	27.1 ab	34.7 b
Full-bodied	25.4 ab	27.1 ab	33.1 b	25.4 ab	26.3 ab	22.0 ab	11.9 a	21.2 ab	28.0 b	30.5 b
Off flavor	17.8 ab	12.7 a	9.3 a	16.1 ab	21.2 abc	21.2 abc	33.1 c	30.5 bc	20.3 abc	16.1 ab
Consistent crema	23.7 c	22.0 bc	21.2 bc	15.3 abc	11.0 abc	9.3 ab	7.6 ab	4.2 a	12.7 abc	18.6 bc
No crema	1.7 a	1.7 a	2.5 a	4.2 ab	2.5 a	3.4 ab	13.6 b	10.2 ab	6.8 ab	0.8 a
Creamy (mouthfeel)	23.7 c	22.0 bc	23.7 bc	24.6 c	17.8 abc	16.9 abc	5.1 a	9.3 ab	14.4 abc	19.5 bc
Chemical/woody/medicinal	4.2 a	6.8 ab	3.4 a	5.9 ab	6.8 ab	8.5 ab	15.3 b	15.3 ab	7.6 ab	6.8 ab
Sample group (defined by MDS)	T	T	T V	V	W	W	X Y	X	Z Y	Z

^aResults expressed as a percentage of citations. For each attribute, values followed by equal letters do not differ significantly from each other at the 5% level by the Tukey's test.

Sample	Acceptability ^a	Sample quality ^a	Sample group (defined by MDS)
C2 – Brand C Superior	5.9 (1.9) ab	3.5 (1.0) a	T
C1 – Brand C Gourmet	5.8 (2.1) ab	3.4 (1.0) ab	T
B1 – Brand B Gourmet	6.1 (2.0) a	3.5 (1.0) a	T V
A1 – Brand A Gourmet	5.9 (2.1) ab	3.5 (1.1) a	V
D1 – Brand D Gourmet	5.2 (2.3) b	3.1 (1.1) bc	W
D2 – Brand D Superior	5.2 (2.2) b	3.2 (1.1) ab	W
Espresso Superior	4.3 (2.3) c	2.7 (1.2) c	X Y
Espresso Gourmet	4.2 (2.3) c	2.7 (1.2) c	X
B2 – Brand B Superior	5.4 (2.3) ab	3.2 (1.1) ab	Z Y
A2 – Brand A Superior	5.7 (2.2) ab	3.3 (1.1) ab	Z

^aResults expressed as mean (standard deviation) of 118 evaluations. For each attribute, means followed by equal letters do not differ significantly from each other at the 5% level by the Tukey's test.

Table 2 shows the consumer responses concerning the acceptability of the products and quality of the samples.

The scores for overall liking ranged from “disliked slightly” to “liked slightly,” which is surprising since these consumers stated they were used to drinking espresso coffee when recruited. However Harwood, McLean, Ennis, Ennis, and Drake (2020) analyzed 11 coffee samples applying PMCAT, and reported that these and other coffee studies also obtained low liking acceptance results. The sample B1 from groups T and V had the highest acceptance, with an average corresponding to “liked slightly,” with no significant difference between the other samples from these groups and those from group Z. The samples from group W presented scores close to “neither liked nor disliked,” with no differences between each other and groups T and V (except for sample B1) and Z. Finally, the samples from group X obtained scores close to “disliked slightly” and differed from all the other samples.

Regarding sample quality, consumers associated the coffee quality with their acceptability. The samples from groups T and V presented the highest quality scores, with means between “good” and “regular,” with no significant difference amongst them and the samples from group Z. The samples from group W obtained intermediate scores, while the samples from group X were considered low-quality samples, with means between “regular” and “bad.”

Consumers did not associate the quality of their own perception with the overall quality printed on the label. The Espresso Gourmet sample was considered to be of low quality, with similar quality to that of the Espresso Superior samples. Thus, consumers did not perceive a similarity between the espresso and coffee capsule samples. In general, the coffee capsule brews were better accepted and were considered as higher quality beverages when compared to the Espresso coffee, probably due to the growing consumption of this type of product. Only the coffee capsule B2 was sorted with the Espresso coffee and was characterized as an acidic, bitter and strong beverage, with a less consistent crema. The CATA results showed that the characteristics that least resembled espresso coffee were weak, characteristic coffee flavor, full-bodied, consistent crema and creamy mouthfeel,

TABLE 2 Acceptability and sample quality of espresso and coffee capsules samples, according to the consumers' opinion

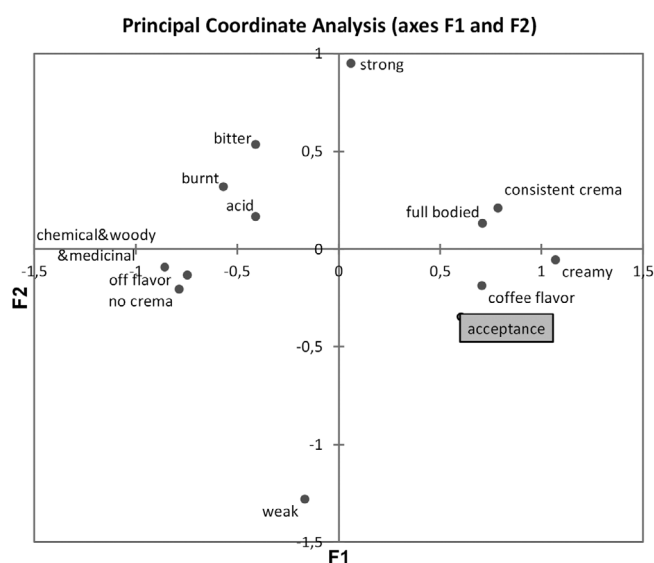


FIGURE 9 Representation of the frequency of mention of the attributes of the CATA versus acceptance of coffees brewed by different methods, for the group of 118 consumers

and the samples B1, C2, and A2 were the most differentiated from the espresso coffees.

Figure 9 shows the principal coordinate analysis plot. By positioning the acceptance vector, the acceptance was shown to be higher in the presence of the attributes full-bodied, consistent crema, creamy and characteristic coffee flavor. The samples A1, B1, C1, and C2, which belong to the groups T and V, presented these characteristics.

On the other hand, lower acceptance scores were observed for the samples presenting the attributes bitter, burnt, no crema, acid, off-flavor and chemical/woody/medicinal flavors. The Superior and Gourmet espressos presented these characteristics.

Brand et al. (2018) studied the combination of sorting and quality scoring to investigate the relationship between the sensory attributes and quality scores to identify groups of wine quality factors. However, the study was carried out with 24 wine industry professionals, who

were trained using a 20-point quality scoring scale. A trained panel has a different point of view with respect to sensory scoring when compared to consumers. They reported that the sorting method was a relatively easy tool that did not require sensory training and could be carried out by both experts and newcomers (Brand et al., 2018). In the current study, sorting was carried out by consumers and they associated the quality with acceptability, despite the efforts of ABIC to elucidate the sensory characteristics of coffee quality for consumers.

We acknowledge one limitation on the first assessment that should be kept in mind was that the presentation of the samples preparation was conceptual, once it would be unworkable to prepare all the extraction methods analyzed to each consumer. Another limitation was that the study used commercial coffees, so there wasn't control of origin, the roast and grind of the coffees contained in the capsules, so that we chose the overall quality printed on the label in order to have comparable samples.

4 | CONCLUSION

The sorting analysis of different brewing methods allowed the understanding of consumers' perceptions of various coffee extraction methods. In the first assessment, where only a visual analysis of the different coffee extraction methods was carried out, they sorted in two groups: one represented by machines that produce espresso-like beverages, and another group representing drip coffees. In the second assessment, which examined and compared the coffee beverages obtained from the capsule and espresso extraction methods, the sorting and CATA analyses allowed for an understanding of the consumer perception of the different samples. The consumers found visual differences, for example, different crema characteristics, and also other properties such as acidity or bitterness of the samples. Thus, the acceptability was related to the presence of several attributes including full-bodied, consistent crema, creamy, and characteristic coffee flavor. In addition, consumers associated the quality of coffee brew to their own acceptability. At this stage, they did not consider the espresso and capsule coffees to be similar. Therefore, although the consumers conceptually consider the coffee capsules to be similar to espresso extraction, differences were observed when tasting the beverage. Thus, the methods chosen in this study proved to be adequate to assess the consumer understanding of coffee extractions, which was improved by the association of Sorting with CATA analyses. The consumers found no similarity between capsule and espresso coffees and were efficient in noticing the differences between the coffee brews studied.

ACKNOWLEDGMENTS

The authors are grateful to the Brazilian National Council for Scientific and Technological Development (CNPq—Conselho Nacional de Desenvolvimento Científico e Tecnológico), the Agribusiness Research and Development Foundation (Fundepag) and to the 3 Corações Companies for their support.

ORCID

Juliana Lustosa Ferini  <https://orcid.org/0000-0001-6302-0680>

REFERENCES

- Abrahão, S. A., Pereira, R. G. F. A., Duarte, S. M. S., Lima, A. R., Alvarenga, D. J., & Ferreira, E. B. (2010). Compostos bioativos e atividade antioxidante do café (*Coffea arabica* L.). *Ciência e Agrotecnologia*, 34(2), 414–420. <https://doi.org/10.1590/S1413-70542010000200020>
- Alencar, N. M. M., Ribeiro, T. G., Barone, B., Barros, A. P. A., Marques, A. T. B., & Behrens, J. H. (2019). Sensory profile and check-all-that-apply (CATA) as tools for evaluating and characterizing syrah wines aged with oak chips. *Food Research International*, 124, 156–164. <http://doi.org/10.1016/j.foodres.2018.07.052>
- Associação Brasileira da Indústria de Café—ABIC. (2017). *Dicas de preparação de café*. Retrieved from <http://www.abic.com.br/publicue/cgi/cgilua.exe/sys/start.htm?sid=39#1>.
- Associação Brasileira da Indústria de Café—ABIC. (2019). *Certificação*. Retrieved from <http://www.abic.com.br/certificacao>.
- Associação Brasileira de Empresas de Pesquisa (ABEP). (2018). *Critério de Classificação Econômica Brasil 2018*. Retrieved from <http://www.abep.org/criterio-brasil>.
- Brand, J., Kidd, M., Van Antwerpen, L., Valentin, D., Naes, T., & Nieuwoudt, H. H. (2018). Sorting in combination with quality scoring: A tool for industry professionals to identify drivers of wine quality rapidly. *South African Journal of Enology and Viticulture*, 39(2), 163–175. <https://doi.org/10.21548/39-2-3203>.
- Cartier, R., Rytz, A., Lecomte, A., Poblete, F., Krystlik, J., Belin, E., & Martin, N. (2006). Sorting procedure as an alternative to quantitative descriptive analysis to obtain a product sensory map. *Food Quality and Preference*, 17(7–8), 562–571. <https://doi.org/10.1016/j.foodqual.2006.03.020>
- Chollet, S., Valentin, D., & Abdi, H. (2014). Free sorting task. In P. Varela & A. Gaston (Eds.), *Novel techniques in sensory characterization and consumer profiling*. Boca Raton, FL: CRC Press.
- Euromonitor International. (2017). *Tendências do Mercado de cafés em 2017*. Retrieved from http://consorcioquesisacafe.com.br/arquivos/consorcio/consumo/tendencias_do_mercado_cafe_2017.pdf.
- Giacalone, D., Degn, T. K., Yang, N., Liu, C., Fisk, I., & Münchow, M. (2018). Common roasting defects in coffee: Aroma composition, sensory characterization and consumer perception. *Food Quality and Preference*, 71, 463–474.
- Godoy, N. T., Veneziano, A. L., da Cunha Rodrigues, L., Schoffen Enke, D. B., & Lapa-Guimarães, J. (2019). QIM, CATA, and Word Association methods for quality assessment of flathead gray mullet (*Mugil cephalus*): Going beyond the trained panel. *Journal of Sensory Studies*, 34(2), e12482. <https://doi.org/10.1111/joss.12482>
- Harwood, W. S., McLean, K. G., Ennis, J. M., Ennis, D. M., & Drake, M. (2020). Comparison of preference mapping with projective mapping for characterizing consumer perception of brewed black coffees. *Journal of Sensory Studies*, 35(3), e12563.
- Jervis, M. G., & Drake, M. (2014). The use of qualitative research methods in quantitative science: A review. *Journal of Sensory Studies*, 29(4), 234–247.
- Kruskal, J. (1964). Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. *Psychometrika*, 29, 1–27. <https://doi.org/10.1007/BF02289565>
- Kruskal, J., & Wish, M. (1978). *Multidimensional scaling*. Wbury Park: Sage Publications, CA.
- Parenti, A., Guerrini, L., Masella, P., Spinelli, S., & Calamai, L. (2014). Comparison of espresso coffee brewing techniques. *Journal of Food Engineering*, 121, 112–117. <https://doi.org/10.1016/j.jfoodeng.2013.08.031>

- Partida-Sedas, J. G., Muñoz Ferreiro, M. N., Vázquez-Odériz, M. L., Romero-Rodríguez, M. A., & Pérez-Portilla, E. (2019). Influence of the postharvest processing of the “Garnica” coffee variety on the sensory characteristics and overall acceptance of the beverage. *Journal of Sensory Studies*, 34(4), e12502. <https://doi.org/10.1111/joss.12502>
- Valentin, D., Chollet, S., Lelievre, M., & Abdi, H. (2012). Quick and dirty but still pretty good: A review of new descriptive methods in food science. *International Journal of Food Science and Technology*, 47(8), 1563–1578. <https://doi.org/10.1111/j.1365-2621.2012.03022.x>
- Vidal, L., Barreiro, C., Gómez, B., Ares, G., & Giménez, A. (2013). Influence of information on consumers' evaluations using check-all-that-apply

questions and sorting: A case study with milk desserts. *Journal of Sensory Studies*, 28, 125–137. <https://doi.org/10.1111/joss.12030>

How to cite this article: Ferini JL, Morales MV, da Silva TA, et al. Consumers' perception of different brewed coffee extractions using the sorting technique. *J Sens Stud*. 2021;36:e12633. <https://doi.org/10.1111/joss.12633>