



CROP SCIENCE

Consumer acceptability and fragrance quality differentiate on of Mogiana coffee types using the Check-All-That-Apply (CATA) method

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Abstract: Coffee, one of the most produced and consumed beverage in the world, has a range of variability in its quality. The aim of this work was to evaluate the consumer capacity to perceive the coffee quality through their fragrance and to verify the influence of previous information about quality on this perception using hedonic scale and Check All That Apply (CATA) sensory tests. The sensory tests were performed in two stages, one without and the other with quality related information of Mogiana coffee samples (Rio, Hard and Soft), and a traditional coffee sample. CATA attributes frequency of occurrence shows that samples discrimination could be done with specific attributes. For Soft coffee the attributes with more occurrence were sweet, caramel, brown sugar, and smooth. The Hard coffee sample was described by the attributes peanut, buttery, and chocolate. While for Rio coffee, the descriptive attributes most often mentioned were strong and burnt. The traditional sample stood out among consumers for its characteristics of old, medicine, sour, burnt, unpleasant and spicy. Therefore, the use of coffee powder fragrance can be alternative to differentiate the quality of the product and its function can be enhanced by passing on information on quality attributes to consumers.

Key words: consumption, fragrance, olfactory perception, sensory analysis.

INTRODUCTION

Coffee is one of the most consumed beverages in the world and Brazil is the biggest producer and exporter, occupying the second position in terms of consumption. Despite new trends such as consumption in coffee shops and innovations in coffee capsules, a research by the Brazilian Coffee Industry Association shows that consumption remains concentrated at home, while roasted and ground coffee represents 81% of total consumption (ABIC 2019). These high consumption evidences also take the industry to adopt education strategies and actions to promote more quality, increase in value of the

Brazilian coffee and conscious consumption (ICO 2017).

A great part of the quality is induced by the physical properties of the product, but in addition to the physical properties, the sensory perception of the product is also based on the expectations based on contextual information (Kumpulainen et al. 2018). However, most of the roasted and ground coffees sold in Brazil do not have quality description in their packaging that allow a careful selection by the consumer (Botelho et al. 2017). Coffee of inferior quality is commercialized because price and preference brand are mainly considered on the purchase due to population habit and the lack of

information in the packaging (Salazar- Ordóñez et al. 2018). There is a greater appreciation of products by consumers when they have prior knowledge of the attributes involved in coffee quality. According to Aschemann-Witzel et al. (2018) the more information the consumers have in the time of purchase, the more value they place on product characteristics.

The need to understand consumer behavior has grown over time and is the focus of investigation, especially by the industries. Among the mechanisms that contribute to the perception of product quality by consumers are the sensory senses, which provide multiple options to create and modify quality perceptions (Asioli et al. 2017). The olfactory perception is being gradually incorporated into the multi-sensory product experience and can be used as an attraction, conservation and even as a quality differentiator, already demonstrated in application for specialty coffees in packages with aromatic valves (Rimkute et al. 2016, Spence 2015, Motoki et al. 2018).

Strategies for the quality products differentiation are fundamental and have been developed mainly in the production but are far from being well succeeded in the markets. In these places the main differentiation attempts were based on extrinsic attributes, and it is important to highlight that quality differentiation also includes the perception of the consumer of specific characteristics of the product, like roast (Salazar-Ordóñez et al. 2018). The coffee quality depends on some factors that influence the development of special sensory attributes, and the fragrance is one of the most important. Although aroma, in general, is used for food odors, according to Specialty Coffee Association of America (SCAA) the definition of fragrance for coffee refers to the smell of roasted and ground coffee when still dry, and the aroma as the smell of coffee infused in hot water (SCAA 2015). Thus,

there is the possibility of using the fragrance of the powder as a mechanism to differentiate the coffee, to further amplify the perception of quality and, consequently, add value to the product.

Among the methods used to study consumers profile it is important to highlight the innovative descriptive test Check-All-That-Apply (CATA) that is used to describe sensory attributes (Santana et al. 2020). Descriptive analysis are often difficult for the food industry in routine application because of the exhaustive training of judges and time required (Llobell et al. 2019). CATA can obtain rapid answers from consumers since with this method intuitive responses can be collected (Heo et al. 2019). Thus, from a list of descriptors previously determined by a trained panel, consumers have to check the options that they consider best describe the product (Jaeger et al. 2020a, Martínez-Navarrete et al. 2019). Many consumer tests have being used the CATA to evaluate food attributes, including coffee ready to drink (Heo et al. 2019), however, to the best of our knowledge studies using CATA for roasted and ground coffee were not reported yet.

In this context, the aim of this work was to evaluate the consumer capacity to perceive the coffee quality through the fragrance of roasted and ground coffee powder and to verify the influence of previous information about quality on this perception using hedonic scale and CATA sensory tests.

MATERIALS AND METHODS

Market research

A quantitative analysis in the form of closed questionnaire was conducted with coffees consumers by using Google Docs online tools (Google®, CA, USA). The questionnaire was divided into three parts. The first part was

applied to know if the interviewed was a coffee consumer, decisive to continue the next steps. The second part of the questionnaire was about the characterization of the profile (age and sex) and frequency of coffee consumption. The third part of the questionnaire containing four questions, two on coffee quality aspects and purchase intention, and other two on the importance of have more quality information in the package and smell the product when buying roasted and ground coffee.

Samples

Coffee samples obtained in the Mogiana region were used in three different classifications, using cup tasting: Soft - soft characteristics and pleasant sweetness on the palate with greater complexity and sophistication; Hard - intense and full-bodied characteristics with less complexity and sophistication; and Rio - unpleasant characteristics on the palate considered to be of poorer quality, and a commercial sample as a control (Table I). The roasting and grinding process of Rio, Hard and Soft coffees were carried out according to SCAA (2015) standards, with adaptations. The samples were maintained in the roaster (Probat Leogap, Germany) during 8 to 9 minutes with initial temperature of 180 °C and final temperature of 200 °C and time mean as described in Table II. The grinding was carried out in the sample Mahlkönig Guatemala (Hamburg, Alemanha) grinder with a granulometry of 2.0, smaller than

recommended by the SCAA (2015), for a better comparison with traditional commercial coffee.

Acceptability consumer test

The test was performed with one hundred (100) voluntary regular coffee consumers in a supermarket. Consumers were served the four samples monadically and randomized. In a first moment the consumers did not receive any specific information about the coffee quality. For each sample, they were asked to rate the overall liking on a 9-point hedonic scale. The 9-point hedonic scale test was applied to the fragrance attribute of the powder, following the methodology cited by Dutcosky (2011), whose extremes varied in the terms “1 – I disliked it extremely” to “9 – I liked it extremely”. After, information about quality of the coffee samples (high, intermediate and low) were provided to the consumer and, thus, for each sample, they were asked to rate the overall liking on a 9-point hedonic scale again (García-Gómez et al. 2019).

Fragrance attributes definition

The sensory analysis was previously approved by the Research Ethics Committee (92878818.3.0000.5148). Preliminary tests were carried out with ten regular coffee consumers, all of whom had experience in sensory evaluation of coffee. First, a fragrance intensity test was carried out using a commercial coffee roasted and grounded in amber cups of different volumes, duly labeled and numbered with three digits at random, wrapped in aluminum foil and delivered in random order. In order to define the

Table I. Samples of coffee used in the present study.

Samples	Coffee type	Origin	Process	Variety	Crop
1	Traditional	Commercial	-	-	-
2	Rio	Mogiana Region	Natural	Mundo Novo	2018/2019
3	Hard	Mogiana Region	Natural	Mundo Novo	2018/2019
4	Soft	Mogiana Region	Natural	Mundo Novo	2018/2019

most suitable container and quantity of coffee to carry out the subsequent tests, the 70 mL amber cup containing 22 grams of roasted and ground coffee was chosen.

Subsequently, a focus group was carried out to define the fragrance attributes of roasted and ground coffee, also to execute the subsequent tests. Each consumer received a form and was instructed to evaluate the samples of roasted and ground coffee Traditional, Rio, Hard and Soft, in amber glass of 70 mL containing 22 grams duly labeled and numbered with three digits randomly, packed in aluminum foil and delivered in random order. Consumers were asked to describe a list of the sensory attributes that characterize the differences between coffee samples in relation to their fragrance attributes.

After individual description of each one, in open discussion, the fragrance characteristics of the coffee samples were finally described and defined by sixteen main attributes: sour, medicine, burnt, fermented, spicy, old, unpleasant, strong, smooth, sweet, citrus, peanut, buttery, caramel, chocolate and brown sugar.

Check-All-That-Apply (CATA) consumer test

The test also was performed with one hundred (100) voluntary regular coffee consumers in a supermarket. The four samples of roasted and ground coffee (Table I) stored in amber glass with thread, wrapped with aluminum foil, properly labeled and numbered with 3 digits random numbers was presented to the consumers.

For each sample, the consumers were asked to complete a Check-All-That-Apply (CATA) questionnaire consisted of the 16 fragrance attributes previously determined. To minimize possible order biases, the order in which the CATA attributes appeared on the ballots was randomized (Jaeger et al. 2020b). For realization of the test, the consumers were assigned to smell the samples from left to right and select all attributes they considered appropriate to characterize each sample.

After, the same test was carried out, but informing that in general there are coffee samples of different qualities (high, intermediate and low), which have different characteristics, including fragrances. Attributes were cited to exemplify these differences, reporting that high quality coffees have soft and sweet characteristics considered Soft coffees. Intermediate quality coffees already have more intense and stronger characteristics, which are Hard coffees. Those of inferior quality have unpleasant characteristics, the so-called Rio coffee. After this explanation, it was reported to all consumers that the samples presented variation in quality. At the end of the test, participants were asked to fill in a questionnaire with background information concerning their demographic and coffee habits.

Statistical analysis

For the market research questionnaire an absolute frequency analysis was realized by the Google Docs online tool (Google®, CA, USA).

Table II. Degree of coffee roasting according to Agtron System (n=3).

Samples	Coffee type	Agtron Repetition			Mean*
2	Rio	51.6	52.3	52.7	52.2
3	Hard	62.1	62.5	63.4	62.6
4	Soft	65.2	63.4	64.2	64.2

*According SCAA (2015) intermediate roast varies from 55 to 65 by Agtron system.

Differences in mean ratings of the sensory attributes were assessed by Analysis of Variance (ANOVA) followed by post hoc comparison by Tukey's Honestly Significant Difference test when significant fixed effects were found (5%). Cochran's Q Test was used to assess differences between samples, over a 400 x 18 matrix, with respect to frequency of mention on each individual CATA attribute (Vidal et al. 2019). Correspondence analysis (CA) were also performed to visualize the frequency of associations of the samples with the attributes of the CATA fragrance, before the information in a 4 x 5 matrix, and after the information in a 4 x 14 matrix. The statistical analysis of all sensory tests were done in the statistical program R version 3.5.2 (R Core Team 2018).

RESULTS

Market research

The questionnaire of market research was answered by 693 coffees consumers, 244

represented men (29.5%) and 488 women (70.5%). Thirty percent (30%) were aged up to 25 years, 53% between 26 and 35 years old, and 17% over 36 years old. Most interviewed people answered that they consume coffee daily (81.2%), which characterizes the high frequency of consumption. For the question "The quality of a roasted and ground coffee is represented in:" the most chosen characteristics were: taste, aroma, purity and origin in descending order (represented by the higher concordance with the expression "I totally agree" in the query). The characteristics of yield, brand and packaging were the most cited by the expression "partially agree" (Figure 1). When the consumers were asked about the "important aspects when buying roasted and ground coffee" the characteristics of taste, aroma and certification stood out as very important requirements. Also, brand, price, packaging and sustainability remaining important aspects reported (Figure 2). Finally, when answer question about "description content in the packaging that help to identify

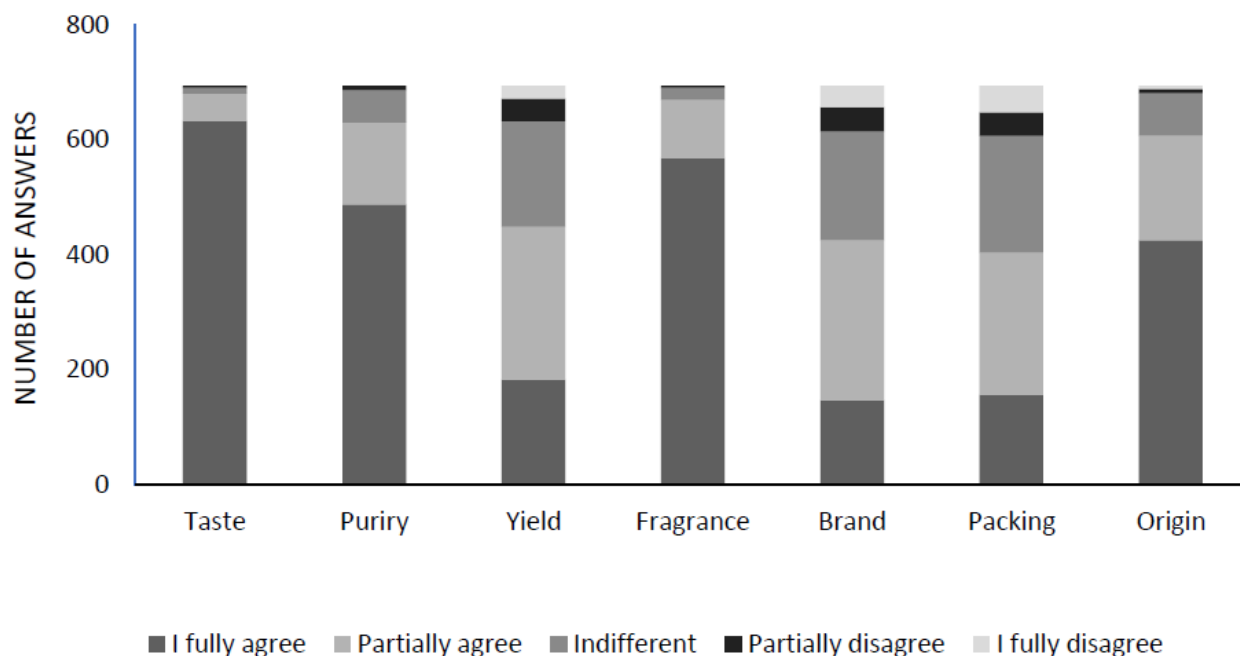


Figure 1. Answers to the market research corresponding to the Question 1 - "The quality of roasted and ground coffee is in: taste, purity, yield, fragrance, brand, packing or origin".

the quality of the product at the purchase time” 618 people agreed totally. And when questioned about if they could “get to smell the coffee powder at the purchase time” 476 people fully agreed with this mechanism in coffee packages (Figure 3).

Sensory analysis

One-hundred consumers participated in the consumer tests on the supermarket, where 67% represented women and 33% represented men, the approach was carried out on a voluntary basis, and women were more interested and willing to participate. Therefore, 40% were under 35 years, 32% between 36 and 55, and 28% were over 55 years. In addition, 42% had monthly income up to 1000 reais, 41% between 1000 and 3000 reais, and 17% had monthly income over 3000 reais.

Mean hedonic ratings for the four coffee samples before and after the information about coffee quality was given to consumers are

reported in Table III. ANOVA results revealed a significant main effect when quality information was given to consumers. It can be observed that consumers without any information differentiated only the Traditional coffee sample from the others, being considered of lower preference (Table III). After the information about quality was given to consumers the result changed and it could be observed differences between the four samples of coffees. Although better understanding the quality of each sample, only the Hard sample remained the same, being the coffee classified as Soft the one with greatest preference, followed by the Hard, Rio and Traditional coffee powder samples. Also, it should be noted that the information about quality also influenced the scores. Only coffees classified as Hard and Soft were accepted by consumers when considering 6 as the minimum score for a product to be accepted (Dutcosky 2011). Following this classification, the previously accepted Rio sample (before information about quality was

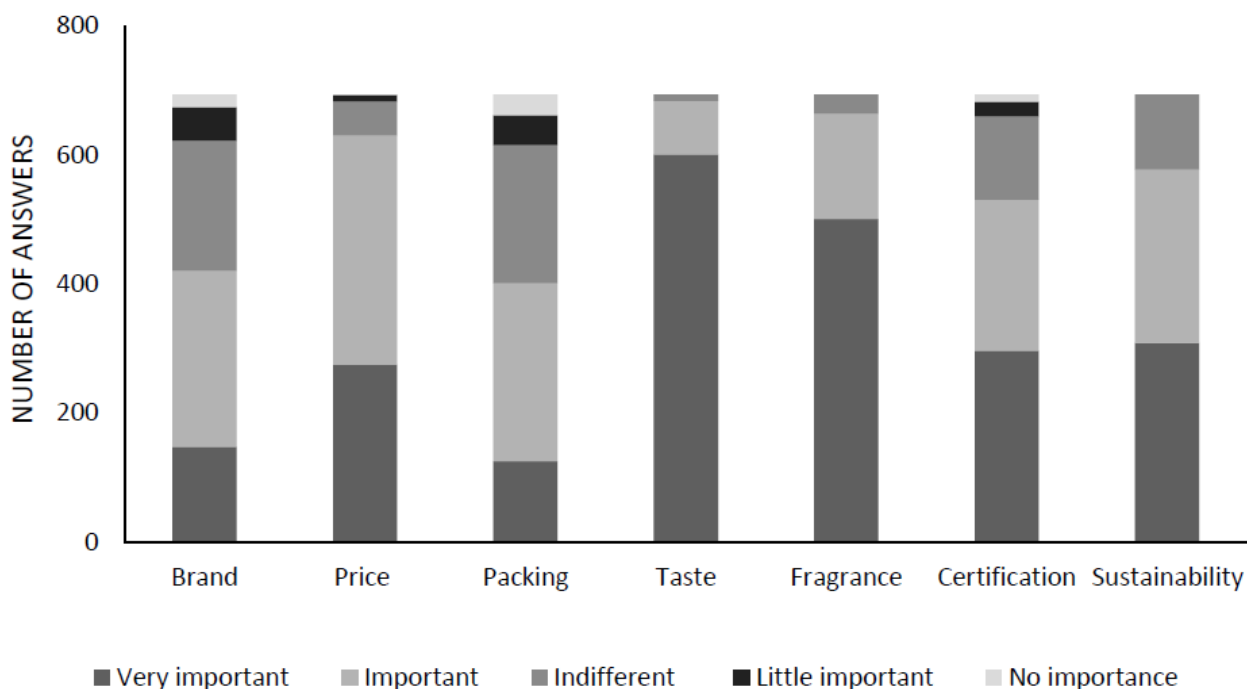


Figure 2. Answers to the market research corresponding to the Question 2 - “Important aspects when buying a roasted and ground coffee are: brand, price, packing, taste, fragrance, certification, and sustainability”.

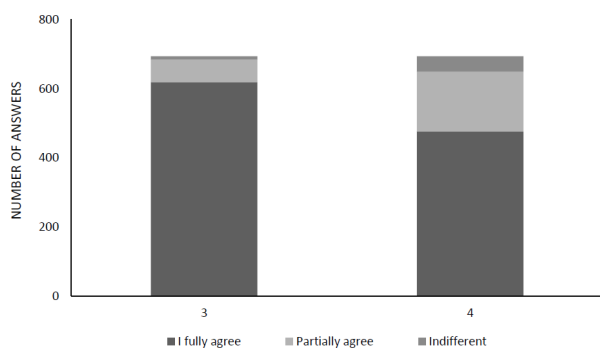


Figure 3. Answers to the market research corresponding to the Questions 3 - "It would be interesting to contain descriptions on the packaging that help identify the quality of the product at the purchase time?" and 4. "It would be interesting to be able to smell the coffee powder at the purchase time to help identify the quality of the product?"

given) was discarded when information about quality was given. Thus, when consumers could be able to differentiate the coffee samples, a greater preference for Soft coffee was registered, followed by Hard coffee and a rejection of the classified as Rio and Traditional. These two samples showed acceptance grades below the minimum established by Dutcosky (2011) and, thus, characteristics of low quality.

Table IV reports the frequency of occurrence of each CATA attributes across the four samples before and after the information about coffee quality was given to consumers. From the results of the CATA in correspondence analysis and Cochran's Q test (Table IV), it can be seen

that the consumer test when realized before the information on coffee quality, showed that the highest attributes occurrence were old, medicine, brown sugar, caramel, and unpleasant. This indicates that these five attributes were more relevant to the consumers. The other attributes did not influence the differentiation and acceptance of the coffee samples obtained before the information about coffee quality was given to consumers. On the other hand, after the information about coffee quality was given to consumers there were more significant attributes in the differentiation of coffee samples (Table IV). Only the attributes "citrus" and "fermented" not presented differences, that is, did not influenced the discrimination of coffee samples.

From the CATA results summarized in Figure 4, which shows the bi-plot of the CA performed on the CATA contingency matrix, it is possible to verify that the attributes that influenced consumers, without previous information, were: old, medicine and unpleasant. This description allows to differentiate only Traditional coffee from the other samples (Rio, Hard, Soft), the least preferred (Figure 4).

The associations between samples and CATA attributes after the information about coffee quality was given to consumers are visually represented in Figure 5. The

Table III. Analysis of the hedonic scale test results before and after the information about coffee quality was given to consumers (mean \pm standard deviation).

Sample	Before	After	t_{calc}	p value
1 Traditional	5.46 \pm 2.39 ^b	3.83 \pm 2.40 ^d	4.814	< 0.001*
2 Rio	6.41 \pm 2.12 ^a	4.96 \pm 2.39 ^c	4.535	< 0.001*
3 Hard	6.90 \pm 1.80 ^a	6.67 \pm 2.10 ^b	0.831	0.407
4 Soft	6.81 \pm 1.84 ^a	7.85 \pm 1.67 ^a	4.189	< 0.001*

^{a-d} Lowercase letters superscript in the same column indicate statistical difference at 5% significance level between the samples in each time.

*In the same row $t_{calculated} > t_{tabulated}$ and $p < 0.05$ indicates statistical difference at 5% significance level between each sample before and after the information about coffee quality was given to consumers.

characteristic that influenced consumers in the discrimination and acceptance of samples of coffee after the information, for Soft coffee, were the attributes of sweet, caramel, brown sugar, and smooth, which can be considered the reason for preference by consumers (Table IV). The Hard coffee sample was described by the attributes peanut, buttery, and chocolate. While for Rio coffee, the descriptive attributes most often mentioned were strong and burnt (Table IV). The Traditional sample stood out among consumers for its characteristics of old, medicine, sour, burnt, unpleasant and spicy, which can be considered the reason for the lowest consumers preference (Figure 5). The CATA test conducted after informing consumers about the coffee samples quality showed a satisfactory acceptability (Table IV).

DISCUSSION

From the results of the market research, an industrial gap about the behavior of coffee consumers in relation to their purchase criteria can be observed. According to Arruda et al. (2009) and Evangelista et al. (2014) the criteria of consumers, in order of preference, is generally in relation to brand and price, with those of quality being few cited. Although price and brand have been mentioned in this research, quality criteria such as taste, aroma, purity, origin and certification stood out. Therefore, it was possible to observe that there is an increase interest of coffee consumers in having more information about quality at the purchase time of the product, being able to better identify by different criteria the product they are buying. Considering the answers from consumers most people agreed totally with the addition of descriptive content on

Table IV. Matching table for the CATA test before and after the information about coffee quality was given to consumers.

	BEFORE					AFTER				
	Traditional	Rio	Hard	Soft	<i>p</i> -value (<i>p</i> < 0.05)	Traditional	Rio	Hard	Soft	<i>p</i> -value (<i>p</i> < 0.05)
Sweet	17	23	28	30	0.144	12	15	31	59	< 0.001*
Old	24	9	12	9	0.006*	33	16	8	2	< 0.001*
Citric	5	4	6	7	0.823	7	11	9	6	0.575
Peanut	10	12	12	4	0.182	3	11	7	16	0.015*
Medicine	11	2	4	2	0.008*	17	11	2	2	< 0.001*
“Rapadura”	3	12	6	16	0.008*	3	3	14	18	< 0.001*
Soft	32	27	35	34	0.634	21	19	38	60	< 0.001*
Fermented	7	4	5	6	0.784	10	8	4	5	0.291
Buttery	2	1	6	7	0.090	3	3	11	11	0.025*
Strong	28	40	32	30	0.317	32	38	34	17	0.007*
Sour	6	9	5	1	0.067	19	10	5	4	0.001*
Caramel	7	13	25	17	0.005*	6	11	13	30	< 0.001*
Burnt	23	25	20	21	0.821	34	37	17	16	< 0.001*
Unpleasant	16	4	3	2	< 0.001*	29	15	2	1	< 0.001*
Chocolate	5	11	12	16	0.080	4	10	22	33	< 0.001*
Spicy	7	7	5	5	0.856	10	7	2	1	0.013*

*In the same row *p* < 0.05 indicates a statistical difference in the level of significance of 5% for each attribute before or after information about quality.

the packaging that help to identify the quality of the product at the purchase time. However, there is a lack of information in coffee packages about quality, in addition to, there are difficulties in recognizing quality, definitions of certifications, and lack of detail in packaging descriptions (Arruda et al. 2009, Evangelista et al. 2014). Also, the olfactory perception was also an important characteristic in the consumers answers. Rimkute et al. (2016) reported that a multi-sensory product experience is being developed and can be used as an attraction, conversation and even as a quality differentiator. Tests with coffee packages with aromatic valves were conducted in application for specialty coffees (Spence 2015, Motoki et al. 2018), being considered a trend within the coffee market.

The hedonic scale results of the acceptance test confirm the results from market research conducted previously. It was able to observe that consumers are recognizing the quality of

the product, seeking information for a better decision. The only possible differentiation from the Traditional sample may be related to the olfactory memory, in other words, the recognition of odors based on previous experiences (Hadley 2004). The Brazilian commercial coffees are characterized by excessive roasting, with low beverage quality, defined as a standard “burned” Brazilian flavor, an extremely dark, bitter coffee with strong fragrance and aroma (Moura et al. 2007). These results are in line with the results of studies that shows that product information affects acceptability and creates a positive expectation for consumers (Botelho et al. 2017, Aschemann-Witzel et al. 2018).

It should be noted that the information about quality provided positively influenced consumers. These results guarantee the best directives to identify and describe coffees with different properties, as observed by Botelho et al. (2017) who found that information about

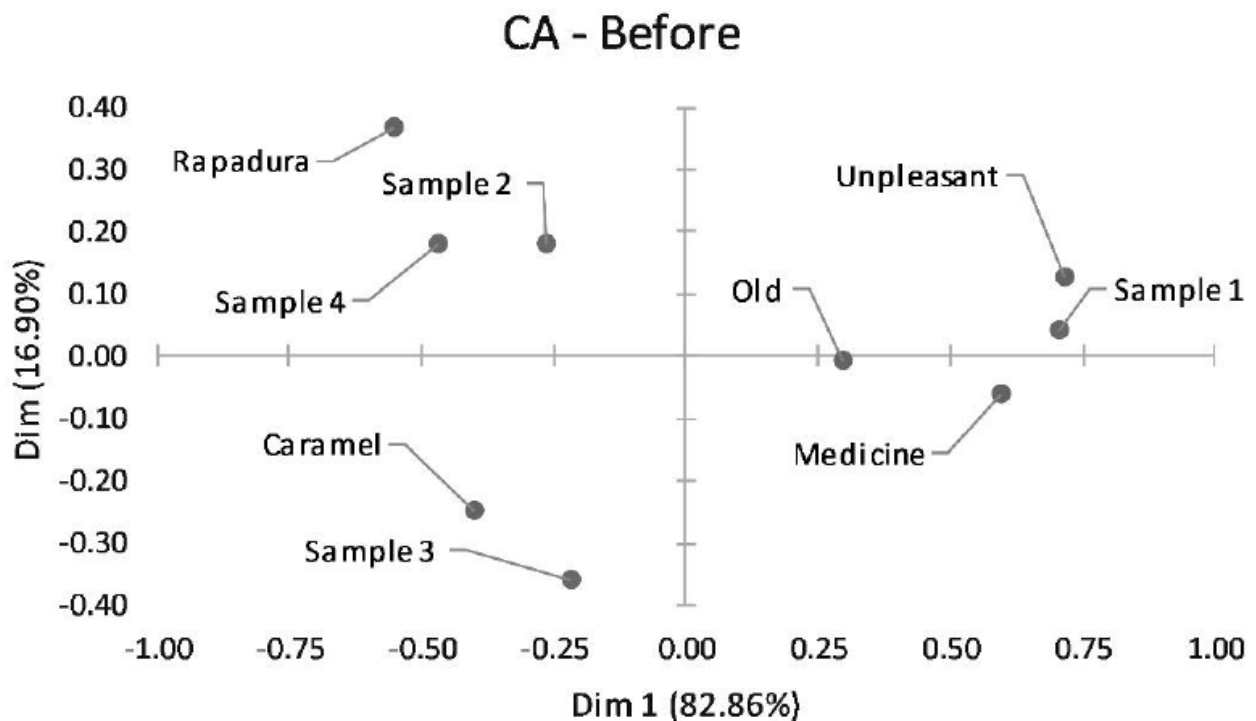


Figure 4. Correspondence Analysis (CA) for the CATA test before the information about coffee quality was given to consumers.

the origin of the grape influences attributes related to better quality. A study with olive oils by Salazar-Ordóñez et al. (2018) showed that information on the olives used in production also influenced the acceptance of the product. In addition, Anchemann-Witzel et al. (2018) studying by-products and passing on information on the advantages and disadvantages of consuming such products, observed the positive contribution of the information.

Giacalone et al. (2019) reported that for coffees with medium roast single variety (only arabica coffee), there is a greater perception of attributes, which are considered characteristic of coffee with better quality. Attributes such as chocolate, caramel, almonds and citrus are examples of these characteristics. Thus, the higher quality of the coffee is related to sweet and floral perceptions that depend on the cultivar, plantation, harvest and post-harvest. On the other hand, when the quality decreases, there is a reduction in the intensity of these

compounds' perceptions with an increase in acidic and burnt impressions (Giacalone et al. 2019). As assessed by these authors, in the present study, the Soft coffee sample was the one with the highest number of descriptors, most attributed to high quality, such as sweet, caramel, brown sugar, and smooth (Table IV). Followed by Hard coffee sample, positive descriptors were identified (peanut, buttery, and chocolate), but for Rio coffee sample, the descriptive attributes most often mentioned were strong and burnt, examples of negative characteristics.

The Traditional sample stood out among consumers for its attributes of old, medicine, sour, burnt, unpleasant and spicy (Figure 5). Bhumiratana et al. (2019), through sensory evaluations made by coffee consumers, identified some characteristics attributed to excessive roasting such as acidity, burnt and roasted. These were similar attributes used by consumers in the present study to describe the Traditional coffee sample, which has a history of having a dark roast.

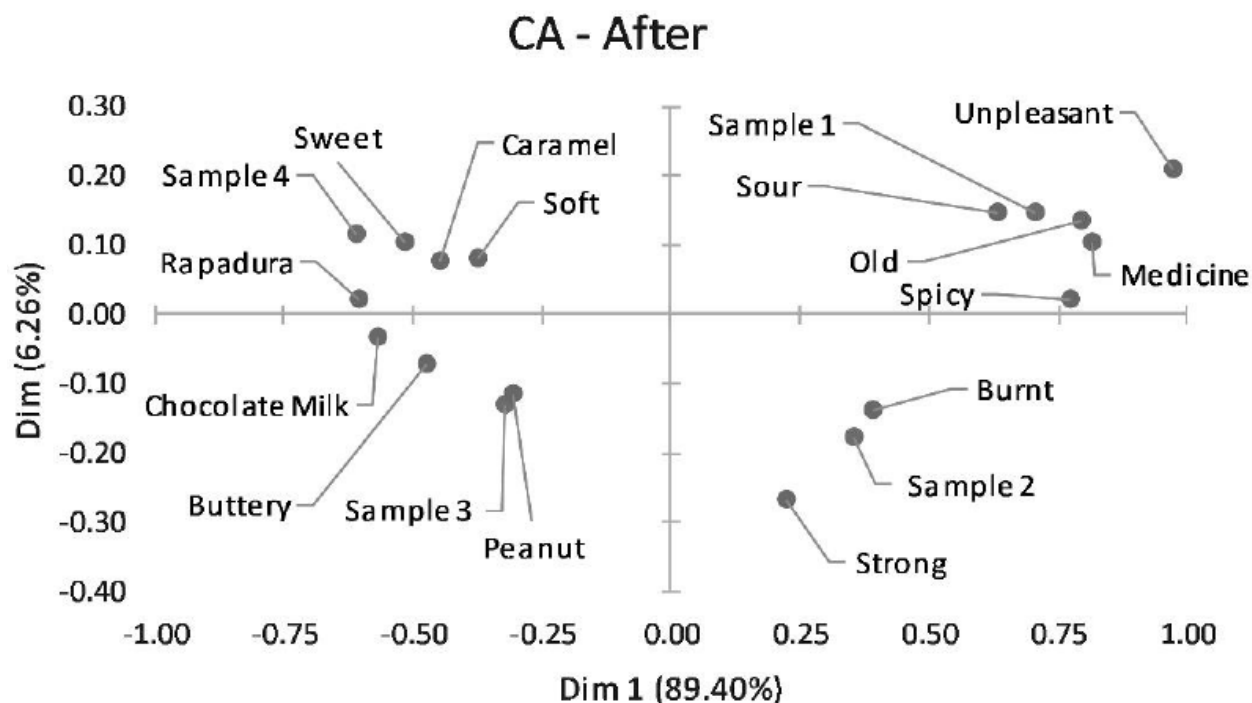


Figure 5. Correspondence Analysis (CA) for the CATA test after the information about coffee quality was given to consumers.

Another point studied about the characteristics related to low-quality coffees, as the Traditional coffee sample, is the blend of Arabica and robust beverages, in which bad attributes are perceived and good attributes are masked by the strong roast (Várvölgyi et al. 2012).

CONCLUSION

The coffee consumer criteria are focused on product quality and they look for new ways to evaluate these criteria or even the product at the purchase time. The use of coffee powder fragrance can be, if felt, an alternative to differentiate the quality of the product at the purchase time, and its function can be enhanced by passing on information on quality attributes to consumers. Thus, investments from the industry are necessary, taking into account the new demands of consumers. Moreover, the possibility of perceiving the fragrance at the time of purchase, together with quality information, will allow value increase to the product and, consequently, gains for the processing industry.

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LZB and RGFAP conceived the study conceptualization. LZB, AEA and FCP conducted the data curation, methodology, formal analysis, and writing, review and editing. CMGL and SV collaborated in the writing. LZB performed the project administration. All authors reviewed and approved the manuscript.

