Characterization of sensory profile by the CATA method of Mexican coffee brew considering two preparation methods: espresso and French press

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ABSTRACT
A sensory evaluation was performed for coffee samples using the Check-All-That-Apply (CATA) method. The samples included Mexican coffee from Hidalgo and Colima states. The brews were prepared by the espresso and French press methods. The data obtained were analyzed using Cochran’s Q test in order to determine any significant differences between samples. There were significant differences ($P < .05$) only in visual attributes, due to intrinsic characteristics of the preparation methods of the samples. Additionally, the results were analyzed using Multiple Correspondence Analysis (MCA), where from a two-dimensional graphic, differences and similarities between samples and attributes were observed. In the same way, it was observed that visual attributes had greater influence for the description of the samples.

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Introduction
Sensory analyses serve to corroborate the quality of coffee batches. These tests are verified by highly trained individuals, called tasters, who form a sensory evaluation panel. Through coffee tasting carried out by a taster panel, tasters could dictate some attributes present in the brew with certain degree of reliability.\cite{1,2}

Some descriptive sensory analysis methods, such as Quantitative Descriptive Analysis (QDA)\cite{3,4}, are widely used in research. Nevertheless, these methods are expensive and the proceedings are too long, which has resulted in long term. Currently, rapid sensory methods have been developed, such as Verbal-based Methods, which provide reliable information to producers and researchers related to sensory characteristics of products. One such method is Check-All-That-Apply\cite{5–7}, which consists of presenting to the judges a compilation of attributes of the product subjected to evaluation and they are asked to select those attributes considered appropriate to describe the sample. Many rapid sensory methods have already been used with coffee, as shown by Nguyen \textit{et al.}\cite{8}, Donfrancesco \textit{et al.}\cite{9}, and Lika and de Toledo\cite{10}, who obtained results with high reliability.

The Mexican state of Hidalgo is the sixth coffee producer in the country, with a production close to 10% of the coffee produced in Mexico (i), whereas Colima state is ranked tenth. The coffee zone of Hidalgo state is located in the Otomi-Tepehua region, where the Secretaría de Agricultura,
Ganadería, Desarrollo Rural Pesca y Alimentación (SAGARPA) has provided support to improve production and productivity of coffee in the indigenous zone of Hidalgo, benefiting three municipalities – San Bartolo Tutotepec, Huehuetla and Tenango de Doria – with repopulation and renovation of coffee plants using the Arabica variety, which is tolerant to rust (ii). Currently, Colima state has 2,198 ha of coffee plantations with 805 producers, established in five municipalities of the northern zone: Comala, Cuauhtémoc, Manzanillo, Minatitlán and Villa de Álvarez. Usually, quality is associated with physical characteristics of the green beans, but recently some sensory attributes of the drink or brew have also been considered.[11–13] In this sense, coffee growers pretend to produce high-quality coffee, making it necessary to know its sensory profile obtained from new plants. For this study, it was used fast sensory analysis, such as CATA, which is cheap and reliable. Besides this methodology is widely used in marketing. However, its use is novel to describe food and the results are comparable with other methodologies used in food studies, such as QDA.

Materials and methods

Coffee samples

Coffee from Colima state

Colima state coffee was obtained from northern Colima state (1000 and 1050 masl) in the Suchitlán community, located 8.5 km from Comala. The property has an area of 4 ha, where Creole Arabica coffee is planted. The Colima coffee zone is formed by the municipalities of Manzanillo, Minatitlán, Comala, and Quesería, located on the slopes of Colima volcano.

The culture process and coffee production were developed artisanally, following a coffee production model in which 100% of the mucilage and cherry husk is used. Currently, the coffee plants are eight years old and have an average height of 3 m. The harvest was carried out between December 2015 and February 2016 with manual collection by workers from Suchitlán. A total of 1.5–2 kg of cherries were obtained from each plant, and only red cherries were collected.

The coffee was allowed to dry for three to four weeks to obtain 5% final moisture, and then was kept in bags and placed on scaffolds. In order to remove the husk from the grain, an endless screw was used, obtaining the green grains. Subsequently, the toasting process was performed by the roasting method using hot air at 200°C for 7 min. Finally, grinding was carried out in a conventional double disc mill.

Coffee from Hidalgo state

Hidalgo state coffee was obtained from the El Mavodo community, belonging to the municipality of San Bartolo Tutotepec, located in the Otomi-Tepehua coffee zone. The property has an area of 15 ha and the average elevation is 1200 mals. The coffee variety used was Arabica and the complete production process was agrochemical free.

The coffee plants were two years old and the production process was organic. The average height was 2 m, and the collection was manual and carried out between January and April 2016. The average yield was 2.5 kg of cherries from each plant, with only red cherries collected.

The fermentation process was carried out for 30 h. The coffee was rinsed in order to remove pulp and leave the grain with husk. The green grains were selected manually. Toasting was performed using hot air at 210°C for 17 min, and grinding was carried out in a conventional double disc mill.

Coffee brew preparation

French press

The coffee brew preparation using French press was carried out in a 1 L press (Starbucks®) with purified water (Bonafont®). The water was heated up until 89°C, and the French press was tempered to guarantee the optimal temperature. Then, 60 g of ground coffee (“Fine Grind”) per liter of water
were used (according to the manufacturer’s instructions), and consequently, the water was spilled, covering all the coffee. The mixture was allowed to rest for 4 min. Next, the piston was pushed softly to the bottom of the press. Additionally, the cups used were tempered at 90°C to guarantee the optimal temperature of the sample, and the samples were presented to the judges immediately.

**Espresso**

The espresso coffee was prepared in a pump coffee machine with 15 bar of pressure (KRUPS®, model Gusto Vivo F880), according to the manufacturer’s instructions. For each sample, 7 g of ground coffee (“Coarse Grind”) were placed in a filter holder (pushing with the measuring spoon) and the final volume of the brew samples was 25 mL. Purified water used (Bonafont®). Moreover, the cups used were tempered at 90°C to guarantee the optimal temperature, and the samples were presented to the judges immediately.

**Sensory analysis**

**Check-all-that-apply (CATA)**

Forty judges took part in this study, the judges were consumers, of which there were 50% men and 50% women, and their average age was 23.8 years. They had a previous meeting where all terms that they considered appropriate to describe the samples were selected, without any restriction of the number of attributes that could be selected. The list was related exclusively to sensory characteristics mentioned in the Mexican norm. The questions of the CATA were multiple choice, which is commonly used in marketing research, in order to reduce responses. The questions consisted of a list of words where the judges select those attributes considered appropriate to describe the sample.

**Data analysis**

In order to analyze the data obtained by the CATA method, first, it was established if the judges had detected significant differences between samples for each term, which was based on Cochran’s Q test. Subsequently, Multiple Correspondence Analysis (MCA) was performed to obtain a two-dimensional graphic of the samples. This analysis provided a graphic in which the differences and similarities between the samples and the characteristic attributes were established. The software used for the data analysis was XLSTAT 17 Windows (StatPoint Technologies Inc., USA).

**Results and discussion**

**Sensory attributes for the CATA test**

The results obtained from the previous meeting are shown in Table 1, which presents the attributes evaluated by the judges. The table shows characteristic attributes of coffee, which are classified in appearance, aroma, and taste/flavor. Those attributes are based on NOM-149-SFI-2000. Within the appearance attributes, the cream and the entire brew were mainly evaluated. Regarding aroma attributes three categories were listed: essences, roast, and distillation. Finally, for taste/flavor, attributes of basic tastes were found, as well as general aspects of coffee and aftertaste.

**Differences between samples**

The Cochran’s Q test was performed to identify significant differences between samples for each attribute included in the CATA analysis. As a result of this test (Table 2), it was found that the calculated p-Value was lesser than the significance level (α = 0.05) in two appearance attributes: persistence of cream and color of the brew. There are many studies related to different methods of preparation and the chemical and sensorial impact in the brew.
that the cream is formed in the espresso method, which is a typical characteristic and one of the
greater sensorial impacts of this preparation, whereas the French press method did not present much
cream. Because of the above, there was a significant difference between samples where the ‘persis-
tence of cream’ attribute was compared.

The second attribute that showed significant differences ($P < .05$) was ‘color’, which could be
because the two preparation methods are completely different. The preparation of espresso results in
a clear drink and the brew is notably dark, crowned with a cream layer, whereas the French press
preparation results in a drink with little or no presence of cream, and the brew had a medium color
with murky a appearance, due to the lees that crossed the piston mesh.

**Multiple correspondence analysis (MCA)**

Multiple correspondence analysis (MCA) is an extension of correspondence analysis (CA) which allows
to analyze the pattern of relationships of several categorical dependent variables. MCA is obtained by
using a standard correspondence analysis on an indicator matrix coded as a binary variable (for this study 1 was indicated when the judges used the attribute to describe the coffee sample, and 0 when judges did not use the attribute to describe the sample). MCA shows each term used to describe the coffee samples (Table 1). It can be observed that coffee samples prepared by the espresso method from Colima and Hidalgo are close (HidalgoE and ColimaE). Additionally, those samples are close to the visual attributes of ‘appearance of cream’, ‘cream colour’, ‘persistence of cream’, and ‘heaviness’, due to the typical visual sensory characteristics of the espresso method, which are also significantly different ($P < .05$) (Table 2) when compared with samples obtained with the French press method. The cream is a visual attribute of great impact for consumers that does not go unnoticed.21–23

In Figure 1, it can also be observed that there are two attributes of taste/flavor that separate espresso samples from French press samples regardless of their origin (Colima or Hidalgo): ‘acidity’, and ‘body’. The judges described the samples obtained by the espresso method homogeneously, which could be due to sensory and hedonic expectations that influence the real perception of food as mentioned by Labbe et al., when the judges observe the presence of cream in the samples, they expect more acidity and body.

On the other hand, the samples obtained by French press are located in the upper quadrant of Figure 1, which did not have significant difference ($P > .05$) with Cochran’s Q test (Table 2). According to the CATA method, the attributes that best described the samples from Hidalgo (HidalgoPF) were ‘salad’, ‘salty’, ‘astringency’, ‘balanced’, and ‘distillation’. The first four attributes belong to the group of taste/flavor, whereas ‘distillated’ is part of aroma. The attributes that best described the samples from Colima (ColimaPF) were ‘aftertaste’, ‘complexity’, ‘shine’, and ‘essence’, which did not have a significant difference ($P > .05$).

![Figure 1. Correspondence analysis (CATA) of the coffee samples and sensory attributes. (ColimaE: Colima espresso; ColimaPF: Colima French press; HidalgoE: Hidalgo espresso; HidalgoPF: Hidalgo French press).](image)
Conclusion

The CATA method is a simple method that provides information about how consumers characterized coffee brews, evaluating specific attributes such as visual, aroma, and taste/flavor, and grouping the information in order to facilitate analysis. Consumers focused on assessing specific attributes of samples, and the attributes they selected were derived from a specific glossary, resulting in easy understanding. Additionally, sensory profiles were obtained that describe the coffee samples. The CATA method allowed efficient evaluation of the differences of the samples obtained from different preparation methods (espresso and French press).

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