WHITE PAPER

BY ABICS

ABICS
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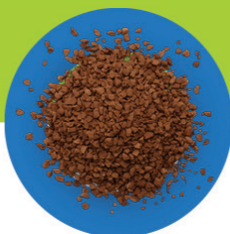
Quality Assessment of
Instant Coffee: A Sensory
Science Development

EXPLORE
& ENJOY INSTANT
COFFEE
BRAZIL

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Instant Coffee: A Sensory
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CONTENTS

1. INTRODUCTION

1.1
IMPORTANCE OF INSTANT COFFEE

Instant coffee accounts for 25% of the coffee consumed in the world and its consumption has been growing over 2% per year. This consistent growth in consumption, even during pandemic times, owes to quality diversification with new blends and new packaging adjusted to the diverse methods of consumption.

Brazil is no exception. The diversity of products and packaging offered has expanded in supermarket shelves providing consumers with countless options. With a 5% share of the total coffee consumed in the country, instant coffee consumption has been growing an average of 3.5% per year since 2016. The total volume consumed today is equivalent to one million bags of green coffee per year. The @ DescubraCaféSolúvel social media campaign has been promoting instant coffee to consumers. Table 1 lists the largest producers and exporters of instant coffee in the world.

LARGEST PRODUCERS				LARGEST EXPORTERS			
2020		**Tons**	**Bags**	**2020**		**Tons**	**Bags**
1	Brazil	122,209	5,295,725	1	Brazil	93,798	4,064,580
2	Mexico	63,715	2.760,994	2	Germany	61,972	2,685,466
3	India	59,673	2,585,831	3	Spain	44,824	1,942,384
4	South Korea	55,822	2,418,962	4	India	37,588	1,628,804
5	Spain	49,572	2,148,140	5	Vietnam	36,349	1,575,112
6	Russia	43,129	1,868,905	6	Russia	25,889	1,121,853
7	Vietnam	42,495	1,841,447	7	Netherlands	23,460	1,016,600
8	Germany	42,345	1,834,944	8	Colombia	22,859	990,567
9	China	38,929	1,686,928	9	Malasya	22,178	961,037
10	United Kindom	38,551	1,670,553	10	Mexico	20,483	887,591

TABLE 1: PRODUCTION AND EXPORTS OF INSTANT COFFEE, 2020, IN METRIC TONS AND 60 KG BAGS. SOURCE: LMC

Brazilian production and exports of instant coffee have been the world's largest for several decades. Brazil also has the largest instant coffee production capacity in the world, of up to 132 thousand tons per year. Exports go to 100 countries with record volumes in 2019, 2020 and 2021, exceeding 4 million bags every year. The instant coffee sector has incorporated new technologies and expanded its industrial capacity in order to face growing global competition. Its manufacturing processes are audited by over 25 different types of international certifications, including good environmental and social sustainable practices and processes, bioterrorism, kosher and halal concepts, and others.

ABICS – the Brazilian Soluble Coffee Industry Association – in cooperation with ITAL – the Institute of Food Technology – have developed a methodology for instant quality assessment that proposes a sensory lexicon and quality grades for instant coffees. The development of this methodology, which started in 2019, had the participation of experts from all instant coffee companies in operation in Brazil and consultants from Brazil and abroad and used the main instant brands in the Brazilian market as well as abroad. This innovative and pioneering methodology assesses quality by its attributes and intensity

and not by scores. This concept allows the consumers to select coffees according to their preference, including the methods of consumption. This way, consumers can identify which products/coffees are most suitable for black coffee, blends with milk, cappuccinos, drinks, gastronomy.

The great revolution in instant coffee is not only about quality and acquiring new consumers but is also about sustainable practices and low-carbon production in partnership with coffee growers. Always pursuing sustainability and traceability, ABICS is a member of the Global Coffee Platform (GCP) and 4C, and has cooperation agreements with coffee growers' entities to develop digital platforms for traceability and sustainability and to offer those tools.

1.2
DIVERSITY OF INSTANT COFFEE PRODUCTS

Coffee is one of the most complex food products. The instant coffee category is often perceived by the market, in terms of diversity and complexity, as a relatively homogenous category. However, that is not the case: the instant coffee category takes off from the already existing complexity of coffee as a product and adds a layer of complexity of its own, based on the instant-coffee processing technology and parameters. This implies the diversity and complexity of instant coffees may be at least as significant as the one found in coffee as a product in general.

The complexity of coffee is given by the combination of many factors along the value chain, each of them with a high level of diversity. The main sources of variability and diversity of the coffee products have been described by Sunarharum et al.[1], who group the variability factors of coffee into agriculture, green bean processing, roasting and grinding, and preparation and serving, each with several factors affecting coffee's diversity and complexity. As examples of agricultural factors, we find genetics (arabica or canephora and their specific varieties), geographical location, climate, cultivation, seasonality, harvest method and ripeness. As examples of green bean processing factors, we find dry processing and wet processing. Roast, in turn, covers level and other parameters.

Instant coffee's diversity takes off from this complexity and adds other layers of diversity with blends, instant coffee technologies and processing parameters. Any specific coffee or blend can be turned into instant coffee. This implies the instant coffee category could already display the flavor and quality complexity of roasted coffees in general – arabica or canephora and their blends; wet method or dry method and their blends; single origin or a blend; any roast level and even a blend of roasts. That alone would imply a huge range of quality level in the instant coffee category, depending on the raw material used. To that, we need to add the diversity brought by the instant coffee technologies and processing parameters.

The first step in the production of instant coffee is extraction. The percentage of extraction – the percentage of the roasted bean which passes into the extract – is already a parameter which brings another layer of diversity to the product and can be controlled at the instant coffee plant. The same coffee will yield very different products, depending on the percentage of extraction used. The coffee extract may be sold as such or dried through different technologies to produce different types of instant coffee products. The main drying technologies are spray dried, which uses a current of warm, dry air to dry the extract, or freeze-dried, which dries the extract through sublimation of ice at high vacuum. Each of these technologies (spray-dried or freeze-dried) will have a different outcome in terms of flavor and quality. Spray-dried coffee may be sold as a powder-like product or further agglomerated to obtain a product which is easier to dissolve. Some of these technologies are more suitable for low-cost products and others are more suitable for premium products. Instant coffees may be further modified through aroma recovery and the addition of micro-ground coffee, to enhance aroma and body.

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1   Sunarharum, Williams, and Smyth, "Complexity of Coffee Flavor: A Compositional and Sensory Perspective."

1.3
THE NEED FOR INSTANT COFFEE QUALITY ASSESSMENT

All products may be said to have a given level of quality, but in complex products, such as coffee, the interrelations between flavor, quality and value are distinctly complex. In coffee, perceived quality is closely linked to its flavor, but also highly influenced by extrinsic factors, such as processing, origin, certifications, and other information about the product[2]. As mentioned in 2.2, any coffee may be turned into instant coffee. This already implies different instant coffees will have a different quality, based on the quality of its raw material. Yet the instant coffee process itself may add another layer of quality, as it modifies to a certain extent the raw material flavor, sometimes imparting a strong over-extracted coffee flavor, while sometimes preserving very faithfully the flavor of the raw material. From a low-quality canephora, extracted at a high extraction yield and dried through spray-drying technology, to a high-quality arabica, extracted at a low extraction yield and dried through freeze-drying technology, the range of qualities for instant coffee may be as wide, if not more, as that of roasted and ground coffee. The value and price of these products should vary accordingly. However, contrary to roasted and ground coffee products, which count with widely recognized quality grading systems, such as the SCA Cupping Protocol, instant coffee products have lacked a system to assess their quality and display it to consumers in a transparent way. For that reason, consumers struggle to understand why they should pay price premiums for certain types of instant coffee. The instant coffee category has not effectively communicated to consumers about the quality diversity of instant coffees, how quality ties to the flavor they should expect and why it is fair to pay premiums for higher quality.

Besides this – or perhaps because of this – the perceived quality of the instant coffee category by consumers in general is usually low. Consumers do not know they can find a wide range of qualities among instant coffees, and perhaps do not know they have not been trying the right instant coffee product for them. This all points to a lack of differentiation within the instant coffee category vis-à-vis consumers.

Yet instant coffees can be Premium easily – they are already hugely diverse, as explained above. It is just a matter of assessing their quality and conveying such quality to consumers in a transparent way. We are presented with the opportunity to develop a quality-assessment and grading system for instant coffees, based on 21st Century sensory science, to convey their quality differences to consumers, in a transparent exercise of product differentiation.

1.4
AN OPPORTUNITY TO INNOVATE COFFEE TASTING SYSTEMS

Coffee quality has traditionally been assessed by the "coffee cuppers" – expert tasters who grade coffee based on their appreciation of quality, after a long training. Although the coffee cupping system has greatly evolved in the past 20 years, the cupping score and the quality grade remain an affective judgement by expert tasters. An SCA cupping score of, say, 84, is the product of an affective assessment, and cuppers' opinions may vary greatly depending on their background, culture, and psychology.

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2   SCA, Towards a Definition of Specialty Coffee: Building an Understanding Based on Attributes (An SCA White Paper).

Furthermore, sometimes tasters do not follow good practices, and a common bad practice is to come up with a "gut-feeling" cupping score instead of analyzing the quality of the different cupping attributes separately[3].

The reason why cuppers vary greatly in their affective assessment is there is no consensus about the level of desirability or undesirability of a given attribute. For example, the attribute "floral flavor" may be very positive for some cuppers and negative for others, depending on what they are seeking for their respective markets.

However, if consensus is achieved around the desirability or undesirability of a given attribute, it is possible to bypass the need for an affective judgement by a taster and grade the quality of instant coffee based on the intensity of several desirable or undesirable attributes. This would make the grading objective, as the quality score is no longer the product of an affective assessment, but the result of the presence and intensity of several desirable or undesirable attributes in the coffee. This would open the door to a scenario where coffee tasters act as descriptive tasters, rating the intensity of several flavor attributes, and the score or grade of the coffee is given as a result of the "desirability weights" of such attributes. This has an additional advantage vis-à-vis consumers: it is directly linked to the flavor they shall find in the product, and quality may easily be communicated in terms of specific flavors.

Applying this "objective" or "descriptive-based" quality grading to instant coffee has several advantages: it shows there is consensus among the instant coffee industry about what attributes are more desirable than others, it shows modern sensory science tools may be applied to the instant coffee category to stimulate transparent product-differentiation, and it endows the instant coffee category with a language to speak to consumers about flavor and quality in a way they will understand.

The first step towards creating a descriptive-based grading system for instant coffees is to identify key flavor attributes in instant coffee. The second step is to identify the links between each of the key flavor attributes and perceived quality, to create a "desirability" weight of each attribute. The third step is to propose a testing and grading method for instant coffees, based on the intensity of key flavor attributes.

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3   Fernandez-Alduenda and Giuliano, Coffee Sensory and Cupping Handbook.

2. A SENSORY LEXICON FOR INSTANT COFFEE

2.1
FINDING FLAVOR ATTRIBUTES RELEVANT TO INSTANT COFFEE

To identify key, differentiating flavor attributes in instant coffee, a collaborative study between ABICS and Campinas Institute of Food Technology (ITAL, Campinas, Brazil) was done. Professional coffee tasters (22) from ITAL and the different instant coffee companies of Brazil participated in a series of 7 tests with different instant coffee samples. For each sample, three cups were prepared using 3 g of instant coffee per 150 mL of boiling water.

In one of the tests, the Sorting method was applied. The tasters were asked to group samples by flavor similarity, and then to describe the characteristic flavor of each group. This was done with two sets of 15 samples. The resulting data were organized according to their similarity matrix. This matrix presents the percentage of times each pair of samples was placed in the same group by the tasters according to their similarities; that is, how close the samples were to each other with respect to the same attributes. This was further analyzed using the multidimensional scale method (MDS), which is used to visualize the distances between objects in a small dimensional space. The descriptors used were listed and organized by frequency analysis. The freely elicited attributes were used to produce a single list where similar terms were merged.

In a following session, the tasters produced a sensory lexicon for instant coffees, based on the key differentiating attributes found in the prior session. Some of the lexicon's attributes are shared with roasted and ground coffee lexicons, such as sweetness, acidity, body, etc[4]. Other descriptors were exclusive to the instant coffee category, such as "over-extracted coffee flavor". The list of descriptors was further refined and backed up with sensory references.

2.2
THE LEXICON

Based on the key, differentiating attributes found by the ABICS/ITAL study, a Sensory Lexicon for Instant Coffee was produced, including sensory references for a 5-point intensity scale, where 0 implies the absence of the attribute and 5 implies the intensity is very high. Table 2 shows the intensity scale used for all attributes. The attributes and their sensory references are listed below.

SWEETNESS: basic taste usually related to sugars. Sweetness is perceived by the palate for more delicate coffees and can be perceived when the salts and acid levels are low. Reference: sucrose at 5 g/L (intensity 1) and 15 g/L (intensity 5).

ACIDITY: basic taste caused by the organic acids of the coffee. Also presented by lighter roasted coffees and those from higher altitudes. Reference: citric acid at 0.25 g/L (intensity 1) and 0.5 g/L (intensity 5).

INTENSITY LEVEL	DESCRIPTION
0	Absence
1	Very low
2	Low
3	Middle/Moderate
4	High
5	Very high

TABLE 2: INTENSITY SCALE USED FOR FLAVOR ATTRIBUTES

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4   Bolger et al., World Coffee Research Sensory Lexicon.

WOODY: see World Coffee Research (WCR) Lexicon entry for "woody".

FLORAL: Le Nez du Café , frascos #11 e #12 (referências qualitativas).

VEGETATIVE: diluted cucumber juice at 5g/L (intensity 1) and 25 g/L (intensity 5). Also, parsley water as per WCR Lexicon entry for "green".

NUTTY: Le Nez du Café[5] vials #11 and #12 (qualitative references).

SPICY: Le Nez du Café vials #7 and #8; turmeric, cinnamon, cloves, nutmeg (qualitative references).

FRUITY: Le Nez du Café vials #11 and #17 (qualitative references).

CHOCOLATY: "Native" brand dark chocolate, 75% cocoa (intensity 5).

HONEY: Le Nez du Café vial #19 (qualitative reference); 4 g/L honey solution.

AFTERTASTE INTENSITY: Perception that remains on the palate after swallowing the beverage or remains in the mouth for a time. Specific instant coffee samples were used as reference.

ASTRINGENCY: sensation of dryness in the buccal cavity after tasting the coffee. Reference: unripe banana (1 bite, qualitative reference).

OVER-EXTRACTED COFFEE FLAVOR: a flavor described as "caramelly", "cooked" and "bitter". Specific instant coffee samples were used as reference.

BITTERNESS: basic taste caused by the presence of three coffee components: alkaloids, chlorogenic and quinic acids, and dark roasts. The perception is more intense at the back of the tongue, generally on swallowing. Reference: caffeine at 0.15 g/L (intensity 1) or 0.45 g/L (intensity 5).

BODY: tactile sensation felt by the palate, with the perception of beverage viscosity. Reference: malto-dextrin at 2 g/L (intensity 1) or 0.60 g/L (intensity 5).

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5   Le Nez du Café - Révélation 36 arômes - Editions Jean Lenoir

3. RELATIONSHIP BETWEEN FLAVOR ATTRIBUTES AND INSTANT COFFEE QUALITY

3.1

INITIAL DEFINITION OF INSTANT COFFEE QUALITY GRADES

As a second stage to develop a descriptive-based grading system for instant coffees, after the development of a sensory lexicon of differentiating key attributes for instant coffee, the relationship between key attributes and perception of quality was explored. This was done by first defining three quality grades through consensus among the Brazilian instant coffee industry members. The three-tier system was inspired by the Minimum Quality Brazilian Standards for Roasted Coffee Beans or Ground Roasted Coffee, according to Resolutions SAA 30 and 31 (2007) and SAA 19 (2010). These Brazilian standards classify the quality of Brazilian roasted and ground coffee in three grades: "Gourmet", "Superior", and "Traditional".

As part of the ABICS/ITAL study (see section 3), Brazilian instant coffee companies decided by consensus on the terms used to name each of the three quality grades: Excellent Instant Coffees, for the top grade; Premium Instant Coffees, for the middle grade, and Classic Instant Coffees, for the basic grade. An initial approach to the definition of the three grades was still part of the ABICS/ITAL study, as tasters were asked to describe the characteristic flavor of each grade. The initial definition reached by the ABICS/ITAL study follow:

EXCELLENT INSTANT COFFEES: Remarkable sweetness and acidity, with intense aromatic complexity, little bitterness and astringency, presence of chocolaty, fruity and floral notes, with a smooth aroma and flavor.

PREMIUM INSTANT COFFEES: Balanced acidity, with presence of woody, nutty and spicy notes, with a little over-extraction coffee flavor, medium potency on the palate, medium to slight bitterness and astringency.

CLASSIC INSTANT COFFEES: Low sweetness and acidity, bitterness and astringency present, strong potency on the palate, full body, with an intense over-extracted coffee flavor, long and lasting aftertaste.

These initial definitions by the ABICS/ITAL study were further refined after the study on the correlation between flavor attributes and perception of quality, which is described in subsection 3.2.

3.2

CORRELATION BETWEEN FLAVOR ATTRIBUTES AND PERCEPTION OF QUALITY

Instant coffee samples (6) were assessed by a panel of 15 expert instant coffee tasters from the industry. Tasters were asked to (a) classify the sample as Excellent, Premium or Classic, based on their own impression of quality, and (b) asked to rate the flavor attributes from the lexicon for each sample, on a scale of 0-5, aided by sensory references (see section 2.2). Each coffee sample was assigned a "true" grade, based on the grade most selected by the group of tasters for that sample. As an example, sample

#315 was considered as "Excellent" by 13 tasters, "Premium" by 1 taster and "Classic" by 1 taster. The Excellent grade was assigned to that sample for the purposes of further statistical analysis regarding flavor attributes and quality grade.

Significant correlations were found between some of the attributes: sweetness and acidity were positively correlated, and so were astringency and over-extracted coffee flavor, while a negative correlation was found between acidity and over-extracted coffee flavor.

An analysis of the p-value of each flavor descriptor showed all descriptors except for body were discriminant among the samples used. In other words, the body level of instant coffee was not found to discriminate between samples. This could be explained either by a lack of training in the assessment of body or – what is most likely – by a similar perceived body level across samples.
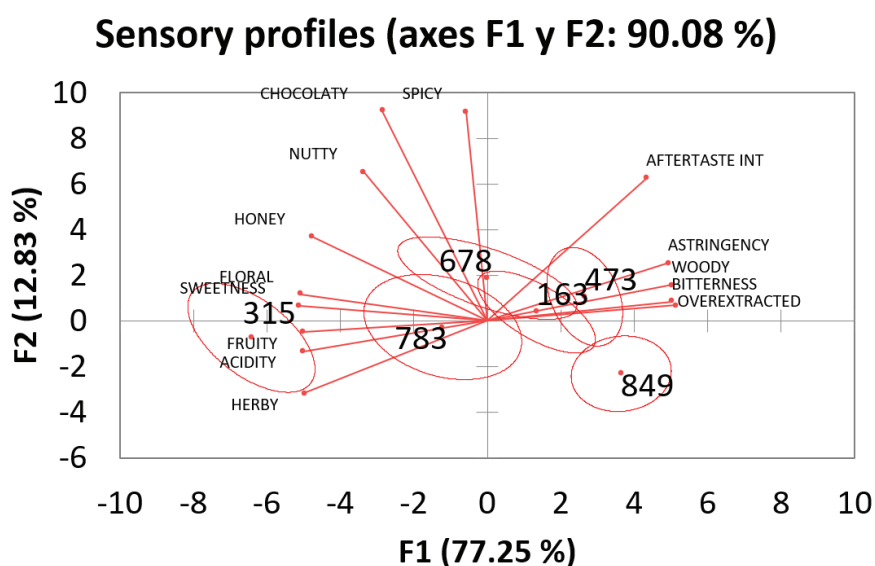
Sensory profiles (axes F1 y F2: 90.08 %)

FIGURE 1: PRINCIPAL COMPONENT ANALYSIS OF FLAVOR ATTRIBUTES AND INSTANT COFFEE SAMPLES

Sweetness, acidity, floral, fruity, astringency and over-extracted coffee flavor had extremely low p-values, indicating a high level of consensus among tasters. Nutty, spicy, and chocolaty, on the other hand, showed much higher p-values, but still significant, in the order of 0.05.

The discriminant power of descriptors was assessed. Save body, all descriptors were found to be discriminant, with acidity, astringency, over-extracted coffee flavor, sweetness and floral as the five most discriminant attributes.

A principal component analysis (PCA) was done to find the sensory profiles of each sample. Factors F1 and F2 together represented 90.1% of the samples' variability, with F1 accounting for 77.3% (see Figure 1). The confidence ellipse of each sample (in red) separated some samples well.

The quality grade was found to vary along F1, with Excellent, Premium and Classic aligned from left to right. In Figure 1, sample 315, on the left end of the graph, was Excellent. Samples 783, 678, and 163 (from left to right) were Premium, and samples 473 and 849, on the far right, were Classic. Descriptors were split by the PCA into what can be understood as "desirable" descriptors (on the left quadrants) and "undesirable" descriptors (on the right quadrants). This means F1 may be used directly to differentiate among quality grades, using the loadings of each attribute along F1 as weights to calculate a quality score. As Figure 1 shows, attributes positively correlated with the quality grade were sweetness, acidity, floral, fruity, herby, honey, nutty, chocolaty and spicy, in order of loading (weight), while attributes negatively correlated with the perception of quality were bitterness, over-extracted coffee

flavor, woody, astringency and aftertaste intensity, in order of loading. Aftertaste intensity is probably inversely correlated with the perception of quality, as the strongest aftertastes are usually unpleasant.

Swetness ·	5.11
Acidity ·	5.00
Woody ·	-5.02
Floral ·	5.08
Herby ·	4.98
Nutty ·	3.37
Spicy ·	0.57
Fruity ·	4.99
Chocolaty ·	2.86
Honey ·	4.78
Aftertaste Intensity · · · · · · · · · · · · · · ·	-4.34
Astringency ·	-4.93
Bitterness ·	-5.14
Over-extracted coffee flavor · · · · · · · · ·	-5.03
Body ·	0.00

TABLE 3: LOADINGS (WEIGHTS) OF FLAVOR ATTRIBUTES ALONG F1 OF THE PCA. THE SIGN HAS BEEN INVERTED, TO MAKE "DESIRABLE" ATTRIBUTES POSITIVE AND "UNDESIRABLE" ATTRIBUTES NEGATIVE.

4. THE INSTANT COFFEE
QUALITY ASSESSMENT SYSTEM

4.1
DESCRIPTION OF
THE QUALITY
ASSESSMENT SYSTEM

The Instant Coffee Quality Assessment System presents several characteristics:

1. It is based on the studies by ABICS and ITAL as summarized in the prior sections.

2. A quality score is produced for each instant coffee. However, the quality score is not an affective score, based on the taster's opinion (as it would be the case for traditional cupping), but a weighed score based on the intensities of key, differentiating attributes. This makes the quality score objective, and replicable by any panel trained using the same references.

3. The quality score is primarily used to determine the quality grade along the scale, but it may also be communicated to consumers.

4. The weight of each attribute was determined by their loading along F1 of the PCA. This means attributes with a higher score are main drivers of the impression of quality among the expert tasters employed. Different market sectors might have different preferences, but the tasters employed are representative of the Brazilian instant coffee industry, which is, by far, the largest in the world. Therefore, it is likely outside markets will share similar impressions of quality or level of desirability for the same attributes.

5. Relevant, desirable attributes shown by a given coffee at middle/moderate to very high intensities may also be communicated to consumers with the confidence they will find them in the product.

The general protocol for the assessment of instant coffee according to this methodology is summarized below:

1. The sample shall be assessed by a group of 6-7 trained instant coffee tasters. These tasters should have been previously trained and calibrated in the assessment of the lexicon's attributes, using the 0-5 scale. The tasters may meet for an in-person tasting session or samples may be shipped to them, for individual tastings. At any rate, samples shall be coded, and no information shall be shared with tasters.

2. Instant coffee samples shall be brewed using 20 g of instant coffee per 1 L of boiling water. The brew shall be stored in an airpot (thermos carafe) and poured into the different tasters' cups at the moment of tasting.

3. Input from tasters shall be entered into a tasting interface (see Figure 2).

FIGURE 2: SCREENSHOT FROM TASTING INTERFACE

4. If needed, tasters shall have access to the sensory references.

5. The input of all tasters for every attribute shall be averaged and rounded to the closest integer number.

6. The mean intensity of each attribute shall be multiplied by its weight as shown in Table 3 – this is the attribute's score. All attributes' scores are added up and 122 shall be added to that sum, to make the final score a positive number. Round to closest integer number.

7. The quality grade of the coffee is determined based on the final score as follows:

      a. Scores of 0-102: *Classic Instant Coffee*

      b. Scores of 102-142: *Premium Instant Coffee*

      c. Scores of 142-306: *Excellent Instant Coffee*

8. The quality grade and the positive attributes with intensity of 3-5 may be communicated to the consumer.

A real-life case is exemplified in Table 4:

Attribute	Mean Value	Weight	Attribute Score
Sweetness	3*	5.11	15.33
Acidity	3*	5.00	14.99
Woody	1	-5.02	-5.02
Floral	0	5.08	0.00
Herby	2	4.98	9.97
Nutty	3*	3.37	10.12
Spicy	2	0.57	1.15
Fruity	2	4.99	9.99
Chocolaty	2	2.86	5.71
Honey	0	4.78	0.00
Aftertaste Intensity	2	-4.34	-8.68
Astringency	2	-4.93	-9.86
Bitterness	2	-5.14	-10.28
Over-extrated flavor	3	-5.03	-15.08
Body	2	0.00	0.00
SUM			18.33
Quality Score (Adding 122 and rounding)			**140**

GRADE: PREMIUM

TABLE 4: SCORING EXAMPLE. THIS COFFEE'S ATTRIBUTES MAY BE COMMUNICATED AS "PREMIUM INSTANT COFFEE WITH SWEETNESS, ACIDITY AND NUTTY FLAVOR", BASED ON ITS POSITIVE ATTRIBUTES WITH INTENSITY 3 OR HIGHER (WITH AN ASTERISK).

4.2
VALIDATION OF THE SYSTEM

As mentioned in section 4.2, the Quality Assessment System was originally developed using a group of 15 expert tasters. However, for routine testing of instant coffee products, the use of such a large group is not practical. Therefore, the system was validated using smaller groups, of 6-7 tasters in each group, to simulate a real-life testing situation. Three small groups of tasters were integrated: Group 1 with 7 tasters, and Groups 2 and 3 with 6 tasters each. Samples 764, 369 and 852 were tasted by groups 1 and 3; samples 199, 485 and 945 were tasted by groups 2 and 3.

An analysis, including PCA, was done on the tasting data from the small groups. In this case, the statistical analysis found nutty, chocolaty and spicy to be non-discriminant flavor attributes. Body, on the other hand, was found to be discriminant but along F2, which means it still plays a small role in quality determination.

Factor 1 (F1) explains 71% of the variability. Table 5 shows the PCA F1 loadings of the six samples, tasted by two groups each, ordered from lowest to highest. The first three digit in each product code indicate the sample number, while the fourth digit indicates the group number. As an example, "852-1" means the results for coffee 852 by Group 1, while "852-3" means the results for the same coffee by Group 3. Coffees 945 and 825 (with an asterisk on the table), were ranked next to each other along F1 by both groups of tasters.

Sample & Group	Position along F1
1--93	-4.278
369-3	-2.656
764-3	-1.820
199-2	-1.817
369-1	-1.456
764-1	-1.261
485-3	-0.610
945-2*	0.002
943-3*	0.744
485-2	2.358
852-3*	4.377
852-1*	6.418

TABLE 5: F1 LOADINGS OF THE SIX COFFEE SAMPLES TESTED BY SMALL GROUPS. THE FIRST THREE DIGITS OF THE SAMPLE CODE INDICATE THE COFFEE, WHILE THE FOURTH DIGIT INDICATES THE GROUP NUMBER.

Another way to visualize the agreement between small groups is Figure 3, which shows a PCA or sensory map for the coffees as tasted by the small groups. For half of the coffees, the assessments from each of the groups were placed next to each other. This is the case of coffees 852 (8521 and 8523), 945 (9452 and 9453), and 764 (7641 and 7643). However, for the other three coffees (485, 199 and 369) their position from one group is not next to the position found by the other group.
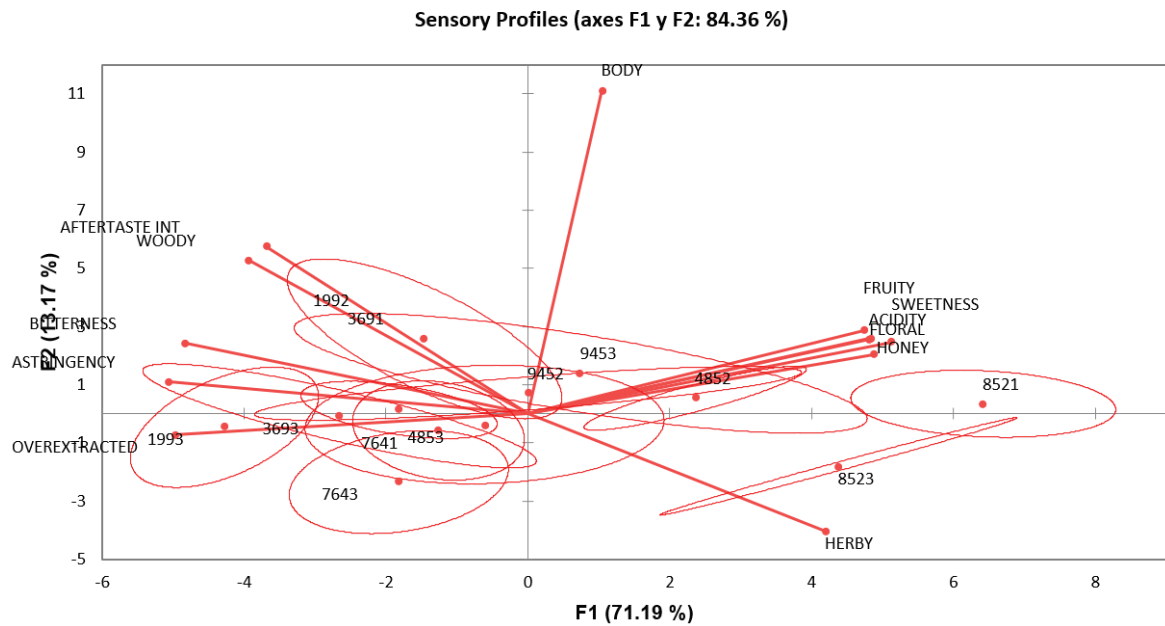
Sensory Profiles (axes F1 y F2: 84.36 %)

FIGURE 3: PCA (SENSORY MAP) OF SAMPLES TASTED BY SMALL GROUPS (6-7 TASTERS). THE FIRST THREE DIGITS IN-
DICATE THE SAMPLE CODE, AND THE FOURTH DIGIT INDICATES THE GROUP CODE (1, 2 OR 3)

When the scoring system described in 5.1 is applied to the results from small groups, we get the scores and grades shown in Table 6. For three of the coffees, the Grade found by both groups is the same (coffees 852, 945 and 199), while the groups disagree on the grade assigned to the other three coffees: Premium and Classic for 764, Excellent and Premium for 485 , and Premium and Classic for 369. Although the grades assigned to these last three coffees were next to each other (in other words, no coffee was assigned both Classic and Excellent!), a higher level of consistency between the grades assigned by small groups would be desirable, before the system is applied commercially.

Sample	Group	Final Score	Grade
764	1	111	Premium*
	3	91	Classic*
852	1	198	Excellent
	3	184	Excellent
945	2	127	Premium
	3	133	Premium
199	2	100	Classic
	3	65	Classic
485	2	155	Excellent*
	3	108	Premium*
369	1	112	Premium*
	3	93	Classic*

TABLE 6: QUALITY SCORES AND GRADES OBTAINED FROM SMALL GROUPS FOR SIX COFFEES. THE ASTERISK SHOWS
A DISCREPANCY ON THE QUALITY GRADE BETWEEN BOTH SMALL GROUPS.

4.3
ASSESSMENT OF INTERNATIONAL SAMPLES

The Instant Coffee Quality Assessment System was also validated through the assessment of 10 imported samples (produced outside Brazil). Though the brand details of the foreign samples shall not be disclosed, the results of the assessment are summarized in Table 7.

Sample	Characteristics	Grade	Positive flavor notes
1	U.S.A. Specialty roaster brand. Single Origin 1	Excellent	Sweet, acid, nutty, fruity, chocolaty.
2	U.S.A. Specialty roaster brand. Blend 2	Excellent	Sweet, acid, floral, fruity, chocolaty.
3	U.S.A. Specialty roaster brand. Blend 1	Premium	Sweet, acid, floral, fruity, chocolaty.
4	U.S.A. Specialty roaster brand. Blend 3	Premium	Sweet, acid, chocolaty
5	U.S.A. Specialty roaster brand. Single Origin 2	Premium	Acid, herby, fruity
6	Latin American coffee shop chain brand	Premium	Sweet, acid, nutty
7	Blend of origins, with micro-ground coffee	Classic	Nutty, spicy
8	U.S.A. Organic "supermarket" coffee	Classic	Spicy
9	U.S.A. Freeze-dried "supermarket" coffee	Classic	Herby
10	U.S.A. Generic "supermarket" coffee	Classic	None

TABLE 7: APPLICATION OF THE INSTANT COFFEE QUALITY ASSESSMENT SYSTEM TO 10 INSTANT COFFEE PRODUCTS PRODUCED OUTSIDE BRAZIL

Several specialty roaster companies in the U.S.A. have launched proprietary instant coffee products, during the past few years, which is effectively Premium instant coffee, as it is sold under a specialty coffee brand at premium prices. This exercise shows that the system, when applied even to coffees produced outside of Brazil, is successfully assigning a "Premium" or "Excellent" grade to all the coffees which are supposedly Premium in the market (specialty roaster and chain coffee shop products). This exercise is also helpful to show the information which would be conveyed to the consumer about each product (the grade plus positive flavor notes at intensity 3-5).

5. CONCLUSION
AREAS OF OPPORTUNITY

The validation results (5.2) show some fine-tuning is required if small groups of 6-7 tasters are going to be used to assess the instant coffee samples. Probably, the best approach would be to do duplicate, blind assessments of the same sample by the small group, to increase the level of confidence. Additionally, the small groups employed could receive more training and become better calibrated. At any rate, once the desired level of confidence is reached at the small group level, the system will be ready to be used, which opens several opportunities for the instant coffee category both within and outside of Brazil.

The most immediate opportunity is the adoption of the system within Brazil, by the instant coffee companies which are members of ABICS. The adoption of a common system of quality assessment, grading, and communication to consumers will open the door to differentiation opportunities in a category which is already diverse but currently lacks a way to convey such diversity to consumers. Consumers will be able to both recognize the different value of each quality grade and learn about the positive flavor attributes present in their favorite brands. This, in turn, will open the door to higher levels of differentiation and value addition, as companies start interacting with the system and develop new products in response to the system.

As the exercise described in in section 5.3 shows, the system can also be successfully applied to international instant coffees. This means there is also an opportunity for the system to be adopted outside of Brazil. Since Brazil is the top instant coffee producer and exporter in the world, it is not unlikely for other countries to adopt the same system, especially when proactively invited to do so by ABICS. This would open the door to a worldwide quality assessment and grading system for instant coffee, which would become a key tool to open new markets and improve the perception about instant coffee quality in mature coffee markets.

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