

**Avaliação de métodos sensoriais descritivos rápidos com diferentes painéis nas variações de características de cervejas envasadas em diferentes embalagens**

**Evaluation of rapid descriptive sensory methods with different panels in the characteristics variations of beers packaged in distinct materials**

**Evaluación de métodos sensoriales rápidos descriptivos con diferentes paneles en las variaciones de características de las cervezas embaladas en diferentes envases**

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## **Resumo**

Dois novos métodos de avaliação sensorial descritiva rápida vêm ganhando espaço no campo de análise sensorial. O método Projective Mapping utiliza similaridades e dissimilaridades como critério, ao passo que Pivot Profile, utiliza os critérios de referência. Este estudo objetivou avaliar painéis de 12 e 24 julgadores, comparando sua reprodutibilidade, e verificar se um painel não treinado com menor número de julgadores, é suficiente para a confiabilidade dos resultados. Amostras de cervejas pilsen em diferentes embalagens foram distribuídas, bem como uma amostra referência, com diferentes características sensoriais. Verificou-se uma leve discordância entre os resultados obtidos em cada um dos testes aplicados. Observou-se uma necessidade de treinamento de curta duração anterior à aplicação do teste para melhor utilização de termos descritivos pelos avaliadores. Além disso, o número de avaliadores influenciou os resultados obtidos, sendo que, os painéis de 24 julgadores, em ambos os testes, foram os que melhor descreveram as características indicadas.

**Palavras-chave:** Análise descritiva; Perfil dinâmico; Mapeamento projetivo.

## **Abstract**

Two new rapid descriptive sensory evaluation methods have been gaining ground in the field sensory evaluation. The Projective Mapping method uses similarities and dissimilarities as a criterion, while Pivot Profile, uses reference criteria. This research aimed to assess panels with 12 and 24 judges, comparing its reproducibility, and evaluate if a non trained panel with a smaller numbers of judges is sufficient for results reliability. Samples of Pilsen beers in different packages were distributed, as well as a reference sample, with different sensorial characteristics. It was possible to observe a slight discrepancy between the results obtained in each of the applied tests. We observed a need for short-term training before the application of the test, aiming for better use of the descriptive terms by the judges. Also, the number of judges influenced the obtained results, being the panels of 24, in both tests, the ones that best described the indicated characteristics.

**Keywords:** Descriptive analysis; Pivot profile; Projective mapping.

## Resumen

Dos nuevos métodos de evaluación sensorial descriptiva rápida están ganando terreno en el campo del análisis sensorial. El método de Mapping Projection utiliza como criterio las similitudes y las disimilitudes, mientras que el Perfil Pivote, es un criterio de referencia. Este estudio tenía como objetivo evaluar paneles de 12 y 24 jueces, comparando su reproducibilidad, y verificar si un panel no capacitado con un número menor de jueces es suficiente para la fiabilidad de los resultados. Se distribuyeron muestras de cervezas Pilsen en diferentes paquetes, así como una muestra de referencia, con diferentes características sensoriales. Hubo un ligero desacuerdo entre los resultados obtenidos en cada una de las pruebas aplicadas. Era necesario un entrenamiento de corta duración antes de la aplicación de la prueba para un mejor uso de los términos descriptivos por parte de los evaluadores. Además, el número de evaluadores influyó en los resultados obtenidos, siendo los paneles de 24 evaluadores, en ambas pruebas, los que mejor describieron las características indicadas.

**Palabras clave:** Análisis descriptivo; Perfil pivote; Mapping projection.

## 1. Introduction

Rapid sensory descriptive methods are quickly gaining space in scientific literature by being useful tools able to detect, describe and quantify sensory parameters in foods (Alcantara & Freitas-Sá, 2018). Some authors indicates that these methods can replace conventional methods that are traditionally performed by the food industry in the development of new products and which requires a well-trained panel (Drake, 2007; Morais, Cruz, Faria, & Bolini, 2014).

These rapid descriptive tests, with qualitative or quantitative evaluation of the sensorial characteristics of a new product, are considered a great alternative due to its less required time and costs (Valentin, Chollet Lelièvre & Abdi, 2012). The Pivot Profile (a reference method) and the Projective Mapping (a similarity method) can be highlighted (Deneulin, Reverdy, Rébénaque, Danthe & Mulhauser, 2018; Esmerino et al., 2017; Pagès, 2005).

The Pivot Profile is a relatively new method, which its technique consists of using a panel of judges who simultaneously evaluate a sample called "pivot", identified as a reference, and other coded samples. During the analysis, judges use descriptors to differentiate regular samples from the reference sample (Thuillier, Valentin, Marchal & Dacremont, 2015; Pearson, Schmidtke, Francis & Blackman, 2020). For the Projective Mapping, judges organize and group

a set of samples on a two-dimensional plane, according to its similarities and differences (Jantzi, Hayward, Barton, Richardson & McSweeney, 2020).

Although these methods are innovative and promising, they need further study in order to elucidate better the technique, especially regarding the number of judges (Esmerino et al., 2017; Mora, Matos, Fernández-Ruiz, Briz & Chaya, 2020). Information referent to an appropriate panel number for descriptive tests are scarce in the literature and opinions are divergent (Heymann, Machado, Torri & Robinson, 2012). Pérez-Navarro et al. (2018) used 11-trained judges in a Projective Mapping approach and Lelièvre-Desmas, Valetin and Chollet (2017) established an 11-members panel in Pivot Profile analysis. It is also possible to verify studies with more than 100 and 123 judges for these methods (Esmerino et al., 2017; Fonseca et al., 2016).

Among the possibilities, these methods can be used to evaluate sensory and non-sensory stimuli such as the influence of packaging information (Carrilho, Varela & Fiszman, 2012). Pivot Profile and Projective Mapping studies, in beer analysis, are still little explored, however it can be relevant considering that the beer packaging influences the conservation, quality and sensory attributes, and can lead to the recurrent purchase of the product (Murray & Delahunty, 2000). The packaging market is significantly growing and several types of materials are used for their production. However, for the packaging of Brazilian beers, only aluminum and glass are used. Even though the product is gaining visibility in the last few years (Carvalho et al., 2020). Showing the importance of more studies in this segment.

Considering the need for more information regarding the influence of the number of judges on rapid descriptive methods, this study aims to analyze the results obtained in panels of 12 and 24 judges for the Pivot Profile and Projective Mapping methods, comparing their reproducibility. It also aims to verify if a small number of untrained judges is enough for the reliability of the result.

## **2. Methods**

It is a laboratory research with quantitative nature, where the operational conditions were properly controlled (Pereira, Shitsuka, Parreira & Shitsuka, 2018). For this, Pilsen-type beer samples were purchased from hypermarkets in the city of Belo Horizonte, MG. Three different brands of beer were used: two of them with two types of packaging (glass and aluminum) and a third brand packaging only in glass (representing the reference sample of the study). All samples of each brand were from the same production batch. Samples were taken to

the Sensory Analysis and Consumer Studies Laboratory (Lasec) of the Operations, Processes and Technology Sector (SOPT) of the Food Department (ALM) from the Faculty of Pharmacy (FAFAR) at the Federal University of Minas Gerais (UFMG), where they were conditioned at 5 °C until analysis.

### **Judges and application of tests**

For the study, 72 judges were recruited. Recruitment took place through flyers at the Faculty of Pharmacy (FAFAR) at the Federal University of Minas Gerais (UFMG) and through digital media on social networks, informing different days and times for application of the test. The target audience was consumers and beer lovers, of both genders and aged between 18 and 60 years. People who showed some aversion to the product as a restriction to gluten or some ingredient present in the formulation, as well as people with some health problem and with continuous use of medications were excluded from the test. In addition, availability, motivation and interest in participating were considered.

All judges were informed about the product, its ingredients and the test procedures, and expressed their agreement to participate through the Free and Informed Consent Form. This research project was approved by the Ethics Committee of the Federal University of Minas Gerais (registry number 96268418.7.0000.5149).

The tests were applied in two distinct moments, varying the number of judges. In the first moment, 12 judges composed the panel for the Projective Mapping test and 24 judges for the Pivot Profile test. In the second phase (after 48 hours), the panel included 24 judges for the Projective Mapping test and 12 judges for the Pivot Profile test, totaling 72 judges in 4 sessions. The number of judges in each test was chosen considering that data in the literature are still inconclusive regarding the best scenario and once these are rapid tests, we aimed to perform two viable realities for running the test in a short period of time.

Samples were presented to the judges in a coded form with three-digit numbers, randomly and balanced, and served in glass bowls. A glass of mineral water for cleansing the palate was also available between the tasting of the samples.

For the Projective Mapping test, the judges received five samples of Pilsen-type beer: B1 (brand A, glass packaging); B2 (brand A, aluminum packaging); B3 (brand B, glass packaging), B4 (brand B, aluminum packaging) and B5 (reference brand, glass packaging).

They were asked to prove each of the samples and to place each of them, in a white sheet (65 x 45 cm), according to their similar characteristics or differences. It was explained to

the panel that they should group them according to their own criteria, with no right or wrong answers. For each test, the X and Y coordinates of each sample were determined, considering the lower-left corner as the origin of the coordinate system (PAGÈS, 2005).

For the Pivot Profile test, judges were asked to prove five pairs of samples (one pair at a time), consisting of the pivot sample (reference) with a coded sample in four pairs and two pivot samples in one pair. Afterwards, they were asked to write which attributes of the coded sample was greater than the pivot sample. This description was not mandatory, so the panel was free to describe the pertinent characteristics of each one, being able to use one or more attributes (Esmerino et al., 2017).

The number of times which each attribute was quoted as “less than the pivot” (negative frequency) and “more than the pivot” (positive frequency) was automatically computed and summed. Subsequently, the negative frequency was subtracted from the positive one for each attribute. The resulting score was then translated by adding the absolute value of the minimum score to all the scores. Thus, the minimum score takes the value of zero and all other scores are positive, yielding a translated frequency table (Fonseca et al., 2016; Lelièvre-Desmas et al., 2017; Thuillier et al., 2015).

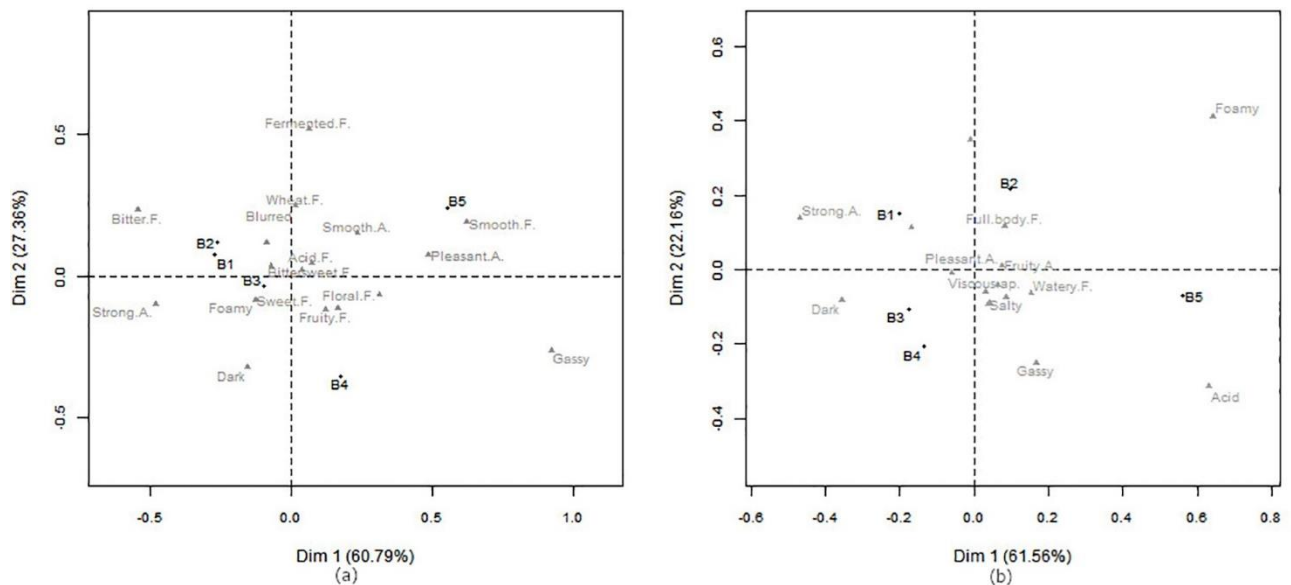
### **Statistical procedures**

The data were evaluated through Correspondence Analysis (CA) for the Pivot Profile test and Multiple Factor Analysis (AFM) for the Projective Mapping test. For both tests, the hierarchical cluster analysis was performed in order to group the samples. All analyzes were performed using the programming language R (R development core team, 2007) and the FactoMineR package (Lê, Josse & Husson, 2007).

### **3. Results**

The Pivot Profile analysis was performed with panels of 12 (Figure 1a) and 24 (Figure 1b) judges. Figure 1 indicates the sensory map containing frequencies of the main attributes cited in 12 and 24 members panel for Pivot Profile analysis. Circles represent the samples, while triangles illustrate the most significant attributes, only those showing  $\cos^2$  above 0.7 were selected.

**Figure 1** - Biplot Projection for Correspondence Analysis for 12 and 24 judges, respectively. The samples B1 represent brand A, glass packaging; B2 brand A, aluminum packaging; B3 brand B, glass packaging, B4 brand B, aluminum packaging and B5 reference brand, glass packaging.



Source: Research Data (2020).

As presented in Figure 1(a) and Figure 1(b), the two dimensions of the map sum up to 88.15% and 83.72% of data variance, respectively.

It was observed in Fig. 1(a) that samples B1, B2 and B3 were similarly distributed in both dimensions, with attributes spread in the quadrants, being both described as "fruity, sweet and foamy". It is noticeable that the panel members were able to distinguish the control sample (B5) from the others, highlighting its pleasant aroma and smooth taste.

Furthermore, the analysis showed that sample B2 and B4 (packed in an aluminum can) was characterized as "bitter" and "gassy and dark", respectively. In addition, B4 was placed distant from the other samples.

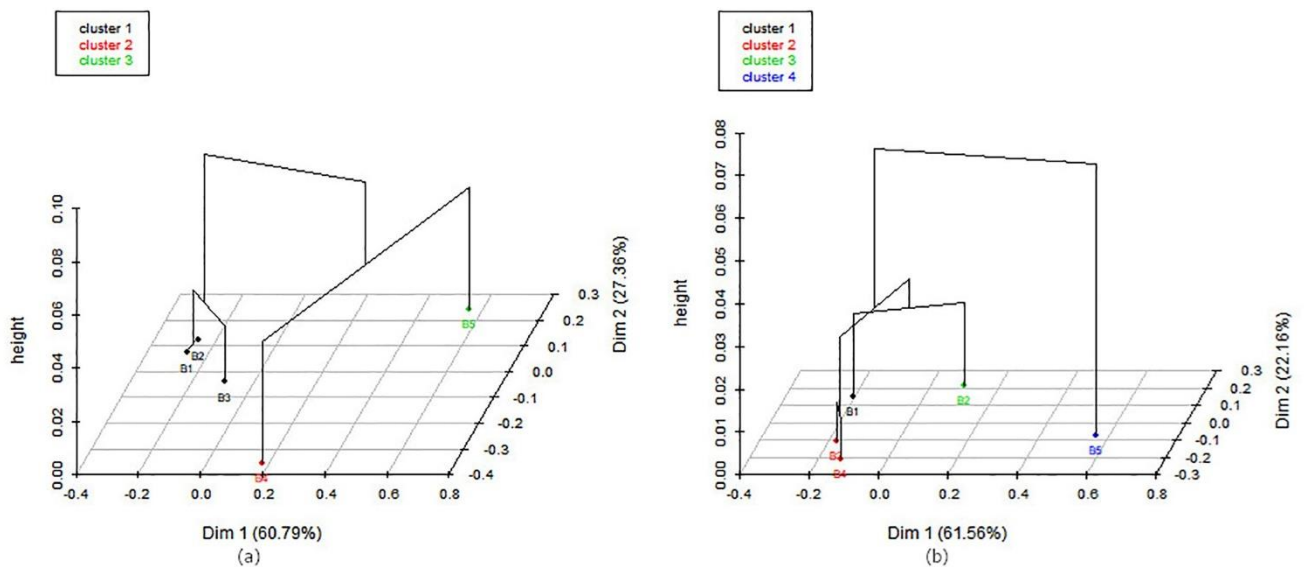
When increasing the number of judges (Figure 1-b), four new groups appeared: B1, featured by strong aroma; B2, featured by full-bodied flavor and fruity aroma; B3 and B4 featured by the dark color, viscous appearance and pleasant aroma and B5, featured by watery flavor, salty, gassy and acid.

In addition, the 12-members panel grouped B1, B2 and B3 samples, separating it from B4, differently from the results of the Pivot Profile analysis with 24 judges.

Dendrograms obtained by cluster analysis from Pivot Profiling for both 12 and 24 judges corroborated with data assessed in correspondence analysis, in which, for 12 judges, we verified

the prevalence of three groups. When applying the dendrograms for the 24 judges in Pivot Profile, four distinct groups are seen, as presented in Figure 2.

**Figure 2** - Dendrograms obtained from the hierarchical cluster on the representation of the beer samples packaged in glass and aluminum packaging, in the first and second dimensions of Correspondence Analysis, using 12 and 24 judges, respectively.



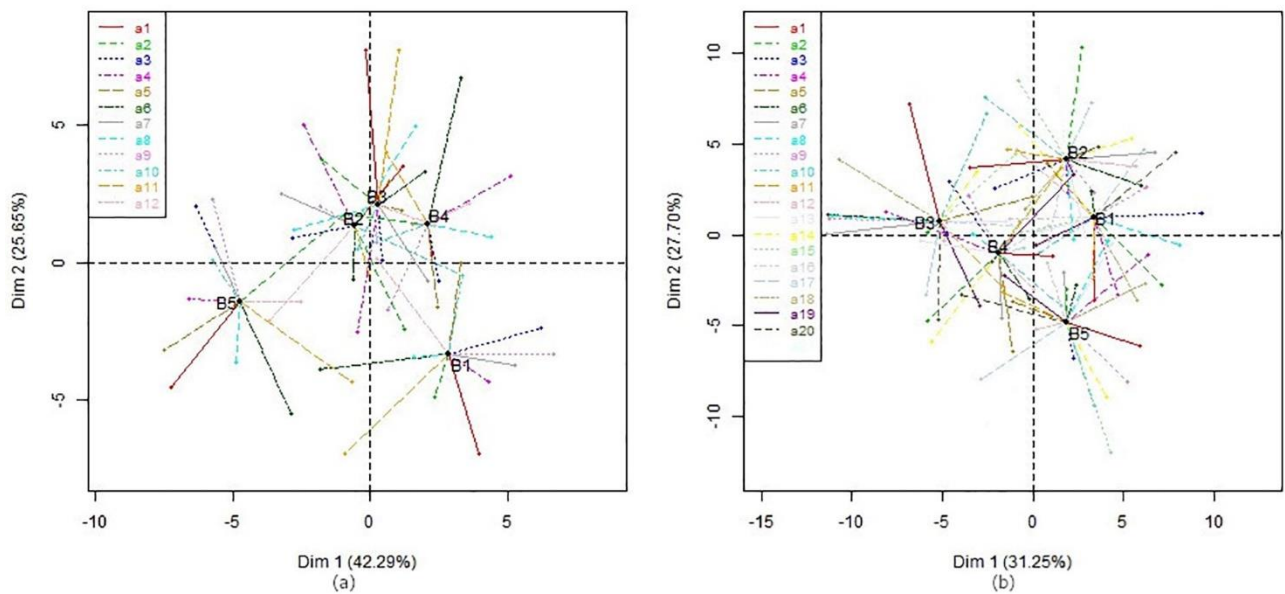
Source: Research Data (2020).

For both tests, the removal/unification of used terms was necessary in order to refine the analysis' quality.

Figure 3 (a and b) indicates the configuration obtained in the multiple factor analysis test, applied to 12 and 24 judges, respectively. The dimensions of this analysis sum up to 67,94% and 58,95% of the data variance.



**Figure 3** - Multiple Factorial Analysis (AFM) for the 12 and 24 judges' panel, respectively.



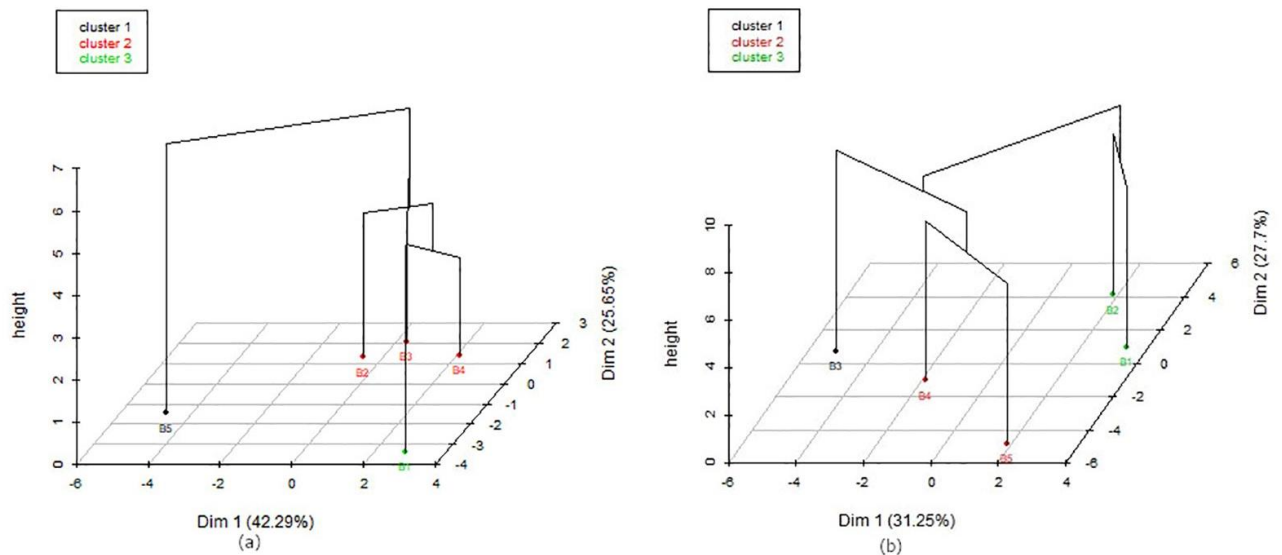
Source: Research Data (2020).

The sample B1 represents brand A, glass packaging; B2 brand A, aluminum packaging; B3 brand B, glass packaging, B4 brand B, aluminum packaging and B5 reference brand, glass packaging. As indicated (Fig. 3-a), samples B2, B3 and B4 were grouped similarly, while samples B1 and B5 were placed in different quadrants.

Results depict that samples B1 and B2 (same brand) were placed within the same quadrant, and samples B3 and B4 placed in opposite quadrants. In Projective Mapping, with 12 or 24 judges, the control sample B5 remained separated from the others.

Figure 4 (a and b) describe dendrograms obtained from hierarchical clustering of the representation of beer samples packed in glass and aluminum, with 12 and 24 judges, respectively. Projective Mapping method corroborated with MFA grouping.

**Figure 4** - Dendrograms obtained from the hierarchical cluster for the Projective Mapping test using 12 and 24 judges, respectively. The sample B1 represents brand A, glass packaging; B2 brand A, aluminum packaging; B3 brand B, glass packaging, B4 brand B, aluminum packaging and B5 reference brand, glass packaging.



Source: Research Data (2020).

Was observed that three sample clusters were formed for both Projective Mapping configurations, as illustrated in Figure 4.

#### 4. Discussion

Regarding the sensory characteristics of the samples, in Figure 1 was observed that the panel members were able to distinguish the control sample (B5) from the others, highlighting its pleasant aroma and smooth taste. A possible explanation for that is the extraction technique called “dry-hopping”, which is performed in B5 sample and could possibly contribute with the observed sensory perceptions. This technique allows differentiating aromatic attributes of hops from different geographic origins (Barry, Muggah, McSweeney & Walker, 2017). It is noticeable that in both 12 and 24-members panels, this control sample could be distinguished from others, corroborating with the hypothesis that the hop extraction method is crucial for the sensory characteristics of this beer, preserving its aromatic compounds.

In addition, sample B4 was placed distant from the other samples. The beer packaging in materials such as aluminum can give the product a metallic effect and bitter taste (Ivušić, Gjeldum, Nemet, Gracin & Marić, 2006).

When increasing the number of judges (Figure 1-b), four new sensory groups appeared. Studies to elucidate information regarding an appropriate number of judges for descriptive tests are scarce in the literature and opinions are divergent (Heymann et al., 2012). This study indicates that for one rapid descriptive analysis, using the pivot profile, the panel with 24 judges was the one with the best performance, gathering the sample groups more coherently, according to its brands.

The configuration of congruence and discriminative power can be elaborated by using the generated dendrograms by hierarchical clusters analysis (Fleming, Ziegler and Hayes, 2015). Thus, this criterion was used in the present study. Figure 2 (a and b) illustrate the Pivot Profile dendrogram for both 12 and 24 judges, respectively.

In general, it is noted that judges can identify the main sensory attributes in both tests. Nonetheless, it is also possible to indicate differences between both configurations regarding attributes fixation, being the 24-members panel with better overall performance (better grouping, considering brand and packaging). This corroborates with the fact that a panel with more judges contributes with better results for this test (Pearson et al., 2020).

According to Lelièvre-Desmas et al. (2017), the analysis performance obtained by Pivot Profiling methods resembles the ones obtained from Projective Mapping. The authors also indicated that Projective Mapping is a suitable method to obtain global information regarding the products. Thus, an analysis using Projective Mapping was performed in order to verify the confirmation of these similarities.

To evaluate data from Projective Mapping, a multifactorial analysis (MFA) was performed. This method aims to integrate distinct variables' groups showing the same attributes. MFA is regarded as a refined principal component analysis (Reinbach, Giacalone, Ribeiro, Bredie and Frøst 2014). Data in Figure 3 (a and b) depicts the number of judges and where the beer samples were placed.

Samples B3 and B4 belong to the same brand and are packed in glass and aluminum, respectively. Judges were able to perceive similar sensory characteristics in those samples. However, sample B1 (glass packed) and B2 (aluminum packed) were placed in different quadrants, which can be explained by the sensory influence of packaged materials.

When analyzing Figure 3 (b), it can be seen that the judges' amount influences a better perception regarding sensory traits in the samples. Vidal et al. (2014) studied 21 sets of samples and indicated that larger numbers of judges (50) provide safer results. Another important aspect that must be taken into account is the complexity of the samples, in which samples that are

more complex require larger numbers of judges, justifying the better performance observed in the present study.

Chollet, Lelièvre, Abdi & Valentin, (2011), pointed it out in the literature a method similar to projective mapping, called Sorting. This method also groups samples according to its differences and similarities. The authors used six different sets of beers and concluded that this method requires a larger number of reviewers, recommending a minimum number of 20 reviewers for analyzing this type of matrix.

As observed in Figure 4 (a and b) Three sample clusters were formed for both Projective Mapping configurations. For 12 judges, samples B2, B3 and B4 remained together, while B1 and B5 are placed in different groups. With 24 judges, the results are different, with samples B1 and B2 remaining clustered, B3 placed in an isolated group and samples B4 and B5 were grouped, possibly due to its glass packaging. Barnett, Velasco and Spence (2016) sensorially evaluated the difference between glass and aluminum packaging beers and found that judges classified the glass packaging beer as having a “better taste”.

When comparing Pivot Profile and Projective Mapping approaches, it can be seen that the number of judges was a decisive factor to better characterize samples. Pérez-Navarro et al. (2018) used 11 trained judges in a Projective Mapping approach and Lelièvre-Desmas et al. (2017) established an 11-members panel in Pivot Profile analysis. It is also possible to verify studies with more than 100 and 123 judges for these methods (Esmerino et al., 2017; Fonseca et al., 2016). Thus, it can be seen that the right judges' amount is yet to be established.

This factor could have influenced data in this current study when results performed with 24 judges for both Pivot Profile and Projective Mapping, presented a more accurate grouping regarding brand and packing type of each evaluated beer.

Thuillier et al. (2015) assayed Pivot Profile as a new descriptive method based on free profiling. Thirteen judges performed the test and the authors concluded that this approach is promising. However, they indicated some experimental and theoretical aspects to be assessed. Varela and Ares (2012) indicate that Projective Mapping is built under the perception of similarities and dissimilarities of a product, aiming to generate a global representation. However, this can be detrimental when consumers are asked about several specific attributes. To overcome this, a short training could refine the obtained information and Torri et al. (2013) emphasize the importance of knowledge and experience about the product in this type of method.

According to Deneulin et al. (2018) several methods were recently developed to reduce the time of training sessions for a vocabulary of conventional descriptive methods. Although

no training was applied, results in the current study suggest that a short training (about 30 or 40 minutes) could have some impact on test quality, as judges would recognize better the product's attributes.

In this study, it was needed to remove or unify some attributes, as "clear" and "bright" (attributes cited in Projective Mapping), for example. These actions could be avoided by training the judges and presenting them with adequate attributes terms to the product.

A descriptive profile based in senses can be complicated, due to the diversity and quantity of generated attributes. Due to lack of training, these terms are generally not bonded to specific definitions and references, so the judges face difficulties managing the analysis (Veinand, Godefroy, Adam & Delarue, 2011).

This profile was stressed in the current study in both Pivot Profile and Projective Mapping methods with both judges' quantity. Difficulty discriminating attributes were observed in all test configurations.

Hopfer and Heymann (2013) assayed wines through Projective Mapping using a 14-members panel. Aiming to assure that all the assessors understood the method, they performed a brief introduction, followed by training exercises. The authors declared that the trained panel was able to detect subtle variations among the samples. On that, to obtain pertinent information and avoid the tendentious conclusion, it is essential to use a trained panel (Queiroga de Paula & Ferreira, 2019).

It should take into account that developing a new technique requires time, available resources, purpose, judges' profile and even practical questions as sample number and product features. When analyzing globally the data obtained in this research, the tests applied provide quick information; however, the conventional descriptive methods remain as the most reliable options (Alcantara & Freitas-Sá, 2018). ). It is important to highlight that the descriptive methods presented in this study, when performed with trained panels, could generate satisfactory data, but more research is required with the matrix analyzed to better elucidate the technique.

## **5. Final Considerations**

Rapid descriptive tests, are considered a good alternative to replace conventional descriptive tests, mainly due to its less required time and costs. In this study, panels composed of 24 judges, in both performed methods, better described the samples' sensory attributes, grouping them with a better likelihood to brand and packaging type. We also observed that

using a short panel without previous training before test application restrains the use of descriptive terms by judges, which can be solved. It can be inferred that the objectives of this study were achieved. However, studies with rapid descriptive methods, such as Pivot Profile and Projective Mapping, still need to be better elucidated, so the present study contributed providing more information, which may be useful for the development of new research. Thus, we suggest that future studies evaluate the application of these methods with a panel that receives a short training before applying the test.

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