



Comparison of conventional descriptive analysis and a citation frequency-based descriptive method for odor profiling: An application to Burgundy Pinot noir wines

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ARTICLE INFO

Article history:

Received 18 December 2008

Received in revised form 6 July 2009

Accepted 3 August 2009

Available online 6 August 2009

Keywords:

Sensory analysis

Descriptive profile

Conventional DA

Frequency of citation

Method comparison

Wine

Pinot noir

ABSTRACT

The limitations of intensity scoring when describing the odor characteristics of a complex product have been documented in the literature. In the present work, the odor properties of 12 Burgundy Pinot noir wines were described by two independent panels performing, respectively, an intensity-based (conventional descriptive analysis) and a citation frequency-based method. Methods were compared according to three criteria: similarity of the sensory maps, control of panel performance and practical aspects. Intensity scoring and citation frequency data were analyzed, respectively, by Principal Components Analysis (PCA) and Correspondence Analysis (CA) followed by Hierarchical Cluster Analysis (HCA). Although both methods underlined the same main odor characteristics (fruity, vegetal and oak barrel), dimensionality of CA was higher (four axes) than that of PCA (three axes), probably as a consequence of the larger number of descriptors employed in the frequency-based method. The clustering of wines differed as well between methods. In conventional DA, one sample exhibiting intense barrel aged related notes was responsible for most of the variance of the PCA map. This induced a settling of the rest of the samples and, therefore, a less fine characterization of the emerging clusters than that obtained by CA. Considering both richness of product characterization and practical aspects, the frequency of citation method might represent a convenient alternative to conventional descriptive analysis when the odor assessment of a complex aroma product is required.

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1. Introduction

Descriptive analysis is a primary tool of food sensory scientists which involves the evaluation of both the qualitative and quantitative sensory characteristics of products by a trained panel. Sensory scientists from academia and food industry have developed several descriptive methods, some of them trademarked, reflecting various philosophies of descriptive analysis. They include the Flavor Profile (Cairncross & Sjoström, 1950), the Texture Profile (Szczesniak, 1963), Quantitative Descriptive AnalysisTM (Stone, Sidel, Oliver, Woolsey, & Singleto, 1974), Sensory SpectrumTM (Meilgaard, Civille, & Carr, 1991), Free Choice Profiling (Williams & Langron, 1984), Quantitative Flavor Profiling (Stampanoni, 1993) and Flash profile (Sieffermann, 2000). However, the most widely used profile technique – based on ISO standard norm 11035 (1994) – combines different aspects from the above mentioned methods and is generally named conventional descriptive analysis (DA). Traditionally, conventional DA is performed by a limited number of judges (from

8 to 15) who have to provide an intensity rating for a set of selected attributes. The key steps of DA are the following:

- Familiarization with the product space and generation of attributes that describe the differences among products.
- Reduction of the initial list of attributes to achieve a list which comprehensively and accurately describes the product space. Redundant and/or less cited terms are grouped on semantic basis and/or eliminated according to judges' consensual decisions.
- Training of the judges. The aims are twofold: reaching a consensus about the meaning of each attribute and achieving intensity rating in a reliable way. To facilitate this task, a definition and physical references are usually associated to each of the attributes present in the list.
- Monitoring of judge performance in terms of discrimination power, reproducibility and homogeneity. The proficiency of the panel is monitored until performance is considered adequate.
- Individual evaluation of the target products, including replications.

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Conventional descriptive analysis assumes that individual percept vary in intensity as a function of stimulus concentration, which is known as the psychophysical model (Lawless, 1999). An assumption of this model is that the odor percept can be analyzed and reported using a set of independent descriptors. Lawless suggests that the psychophysical model may not be adequate for complex odor mixtures and claims that “the use of simple and apparently independent intensity scales may produce the illusion that the odor experience is a collection of independent analyzable notes when it is not” (p. 325). To short these limitations, some authors have pointed that similarity-based approaches, such as the sorting task (Blancher et al., 2007; Cartier et al., 2006; Lawless, Sheng, & Knoops, 1995; Lim & Lawless, 2005; Saint-Eve, Kora, & Martin, 2004; Tang & Heymann, 2002), projective mapping (Risvik, McEwan, Colwill, Rogers, & Lyon, 1994; Risvik, McEwan, & Rodboten, 1997) or napping™ (Pages, 2003; Perrin et al., 2008) procedures followed by a description of each sample or groups of samples are better suited to deal with complex perceptions. In a recent work Lelievre, Chollet, Abdi, and Valentin (2008) have studied the validity of this approach. In their study, participants had to sort nine commercial beers and then describe each group either with their own words or with the aid of a list of terms. The authors concluded that a sorting task followed by description might be more adapted for studies focused in assessors' behavior rather than in studies looking for a precise and reliable description of complex products such as beers. Sorting and napping™ do not require a training phase and are generally performed by judges that have previously participated in descriptive tasks but are not necessarily trained together on the specific product set. Therefore, they can be an alternative to conventional DA when a rapid access to the relative sensory positioning of a set of food products is of primary concern. However, several authors (Delarue & Sieffermann, 2004; Lelievre et al., 2008; Perrin et al., 2008; Saint-Eve et al., 2004) agree that such approaches are less suited than conventional DA when detailed information of sensory properties of products is required.

Since the first developments of sensory profiling, conventional DA has been widely used to evaluate a variety of food products, as evidenced by the abundant scientific literature existing to this respect. Conventional DA is generally well adapted when applied to simple products, but is less suited to profile complex products, especially when dealing with odor (Lawless, 1999). A plausible explanation for this could be the difficulties of humans to discriminate odor qualities in a mixture, as stated in the works of Laing and co-workers (Laing, 1991; Laing & Glemarec, 1992; Marshall, Laing, Jinks, & Hutchinson, 2006). The authors studied the ability of subjects to identify the components of mixtures of common odorants and showed that participants had a great difficulty in identifying common odors in even the simplest of mixtures. The limited capacity of humans to reliably differentiate concentration and/or intensity levels in a mixture, has also been showed in the literature (Engen & Pfaffmann, 1959). Participants, on the average, could accurately identify only about three levels of odor intensity, compared with other sense modalities where seven or more levels could be accurately discerned. On the basis of these findings, Lawless (1999, p. 328) questioned the suitability of intensity scales to assess odor properties: “If people are hard pressed to discern levels of odor magnitude, does it make sense for them to be asked to profile odors on intensity scales?”. The question underlined by this author seems especially pertinent when dealing with a complex aroma product composed of hundreds of odorant compounds – many of them at concentrations near their olfactory thresholds – such as wine.

Within this framework, a first alternative to conventional DA could be flash profile (Sieffermann, 2000). In this technique, samples are assessed in a comparative way and ranked according to

every single attribute, which avoids the use of intensity scoring. This method had been showed to provide sensory maps similar to those of conventional DA when applied to a variety of food products such as jams (Dairou & Sieffermann, 2002) dairy derivatives (Delarue & Sieffermann, 2004) or jellies (Blancher et al., 2007). A limitation of this technique is, however, the difficulty to process data due to the lack of tools to evaluate and compare the semantic descriptions yielded by judges (Delarue & Sieffermann, 2004).

Another alternative to intensity-based techniques is the use of citation frequency-based techniques. McCloskey, Sylvan, and Arrhenius (1996) and Le Fur, Mercurio, Moio, Blanquet, and Meunier (2003) used this approach to characterize the aromas of Chardonnay wines from California and Burgundy, respectively. A list of descriptors was provided to judges, who had to choose the most pertinent ones to describe a given wine. Scores were computed from the number of times a term was selected for a given wine by the judges. More recently, Campo, Do, Ferreira, and Valentin (2008) used this technique to describe Spanish white wines. In this study judges were trained in the use of a generic pre-specified vocabulary list which was modified throughout training to achieve concept alignment. The final list contained a relatively large number of terms (73) organized in a hierarchical way inspired from the aroma wheel (Noble et al., 1987). This special feature allowed judges to describe a wine with the characteristics they could better identify either at a generic level (floral) or at a more specific one (rose). Moreover, the large number of available terms allowed judges to precisely describe their perception using the most appropriate term for them. Within this approach judges had to select a maximum of five terms from the list which seemed pertinent to characterize a wine. Scores were computed from the number of times a descriptor was selected (frequency of citation). In view of these studies (Campo et al., 2008; Le Fur et al., 2003; McCloskey et al., 1996), the frequency of citation method seems well adapted to characterize wine samples. However, little is known about the practical aspects and the relevance of the results in comparison to conventional DA, which is a reference method in sensory science. Hence, the scope of the present work is to compare the frequency of citation method with conventional descriptive analysis when evaluating a complex product such as wine. The comparison between methods will be based on three main axes: (i) panel monitoring, (ii) similarity of sensory spaces and associated descriptions and (iii) practical aspects regarding method implementation. In order to compare the discrimination power of both methods we selected Burgundy Pinot noir wines with and without aging potential. According to wine experts, wines with an aging potential are wines presenting particular sensory characteristics that can improve in quality after years of keeping. The so called “vins de garde” are an important economic stake in major French wine areas that have a prestigious image linked to tradition and local producing practices (Langlois, Ballester, Campo, Dacremont & Peyron, in preparation). Therefore, an additional scope of the present paper will be to explore whether a segmentation of wines according to this classification is achieved by any of these methods.

2. Materials and methods

2.1. Wines

The sampling set consisted of twelve Pinot Noir wines from 2005 vintage produced in different appellations of controlled origin from Burgundy region (Table 1). Six of the samples were judged by a panel of 23 professionals in the wine field in Burgundy (6 women and 17 men ranging in age from 32 to 74 years, median age 42) as wines with an aging potential (Langlois et al., in preparation). The samples were all commercially available wines of med-

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