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Dynamic characterization of red wine astringency: Case study with Uruguayan Tannat wines

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ABSTRACT

Astringency is one of the most important sensory characteristics of red wine. It involves several mouth-feel sensations, which have been commonly used to describe red wines. However, the dynamics of astringency sensations have not been previously studied. In this context, the aim of the present work was to obtain a dynamic description of the astringency of red wines. Seven commercial Uruguayan Tannat wines were evaluated in triplicate by a panel of 9 trained assessors. They were asked to describe the astringency of the wines during 40 s in a Temporal Dominance of Sensations (TDS) task comprising a list of 8 terms: 'dry', 'fine emery', 'harsh', 'mouthcoating', 'puckery', 'rough', 'silky', and 'velvety'. After completing the TDS task they were asked to rate global astringency intensity using an unstructured scale. The wines significantly differed in their average global astringency intensity. Between two and three terms were significantly dominant to describe the astringency of each of the seven wines and enabled to discriminate samples with different astringency characteristics. Samples differed in the dominance of the terms and the time elapsed until they became dominant. Wines which did not significantly differ in their average astringency rating showed different dynamic astringency profiles, which evidenced that the dynamics of astringency characteristics were not related to global astringency intensity. TDS seems to be an interesting methodological choice to characterize the dynamics of wine astringency and opens new possibilities to better understand this complex sensory characteristic.

1. Introduction

Astringency is one of the most important sensory characteristics that define the complexity and quality of red wine (Peynaud, 1987). It is a tactile sensation, caused by the interaction of polyphenolic compounds and salivary proteins, which leads to a decrease in the lubrication of the oral ephythelium (Lyman & Green, 1990). Astringency can be basically defined as "the complex of sensations due to shrinking, drawing or puckering of the epithelium as a result of exposure to substances such as alums or tannins" (ASTM, 2004).

Unlike taste sensations, astringency perception is strongly time-dependant (Guinard, Pangborn, & Lewis, 1986). Perceived astringency intensity has been reported to increase after ingestion (Ishikawa & Noble, 1995), and can last up to six minutes after expectoration or swallowing (Lee & Lawless, 1991). For this reason, time-dependent methods are necessary to fully characterize the astringency of red wine (Ishikawa & Noble, 1995; Noble, 1995).

One of the most popular methods for astringency evaluation is time intensity (TI), which relies on continuous measurement of astringency intensity over a period of time (Colonna, Adams, & Noble, 2004; Lee & Vickers, 2010; Ross, Hinken, & Weller, 2007; Valentová, Skrovánková, Panovská, & Pokorný, 2001). This method provides a detailed characterization of astringency development during consumption (Cadena, Vidal, Ares, & Varela, 2014; Robichaud & Noble, 1990). However, astringency intensity is usually insufficient to characterize all the sensations that are simultaneously experienced when consuming red wine (Bajec & Pickering, 2008).

Astringency has been reported to be a complex perceptual phenomenon that involves several sensations that are simultaneously perceived (Green, 1993). A wide range of subtle sensations have been traditionally used by wine tasters and researchers to describe wine astringency, including: 'drying', 'puckering', 'rough', 'sappy', 'harsh', 'woody' and 'green' (Lawless, Corrigan, & Lee, 1994; Lee & Lawless, 1991; Peynaud, 1987). Gawel, Oberholster, and Francis (2000) proposed a mouth-feel wheel to precisely and comprehensively characterize the astringency of red wines. This wheel includes 33 astringency descriptors grouped into 7 categories ('particulate', 'surface smoothness', 'complex', 'drying', 'dynamic', 'harsh', 'unripe'). Several authors have used this list to describe the astringent sensations of red wine (Francis et al., 2002; Gawel, Iland, & Francis, 2001; Pickering & Robert, 2006).

Astringency description has been performed using static methods, i.e. a single astringency description was obtained by averaging the sensations perceived during consumption. Lee and Lawless (1991)

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presented evidence of the time dependency of the sub-qualities of astringency. These authors reported that the temporal evolution of total astringency and drying, puckering and roughing sensations differed. However, the dynamics of astringency sensations has not been fully studied yet. For this reason, dynamic methods could contribute to a more comprehensive description of the astringency of red wines during consumption.

Temporal Dominance of Sensations (TDS) is a novel temporal method which enables assessment of the temporal sensory profile of products by simultaneously evaluating all the sensations perceived (Pineau et al., 2009; Meillon, Urbano, & Schlich, 2009; Cadena et al., 2014). The method consists of presenting a list of attributes to assessors, who are asked to select which attribute is perceived as dominant at each moment of the evaluation, i.e. the attribute that catches the attention at a given time, not necessarily the most intense (Pineau et al., 2009). Along the evaluation, each time the dominant attribute changes the panelists have to select the new dominant sensation. This methodology has already been used for dynamic sensory characterization of wine (Meillon et al., 2009; Sokolowsky & Fischer, 2012), which makes it a good methodological choice for dynamic characterization of astringency.

In this context, the aim of the present work was to obtain a dynamic description of the astringency of Tannat red wines using Temporal Dominance of Sensations.

Tannat is a red cultivar of *Vitis vinifera* which has become the emblematic wine of the Uruguayan wine-making industry (Carrau, 1997). It is one of the varieties with the highest content of anthocyanins and other polyphenolic compounds (Alcalde-Eon, Boido, Carrau, Dellacassa, & Rivas-Gonzalo, 2006; Boido et al., 2011), which makes astringency one of its differential characteristics. Considering that Uruguay is one of the few places in the world where Tannat is grown, research on the viticulture and enology of this variety is still necessary to better characterize its wine quality potential.

2. Materials and methods

2.1. Samples

Seven commercial samples of Uruguayan varietal Tannat wine, sold in the Uruguayan market, were selected for the study and obtained directly from the wineries. Samples were selected to represent high quality Uruguayan Tannat wines with different characteristics in terms of vintage, price segment and aging in oak barrels. Wines were bottled in 750 mL bottles and were conserved under 15 °C until their analysis. A description of the wines is shown in Table 1.

Alcohol content (% v/v) and total acidity (g/L expressed in tartaric acid) were determined by FTIR-spectroscopy (FOSS WineScan™ FT 120, Denmark) accurately set in line with Vine and Wine International Office official methods. Total polyphenol index was determined according to Iland, Ewart, and Sitters (1993), by measuring the absorbance at 280 nm of 1:100 dilutions of the wines in water. For tannin concentration the method proposed by Ribéreau-Gayon and Stonestreet (1966) was used. Wine samples were diluted 1:50 in water, and 4.0 mL of the dilution were placed in two tubes with 2.0 mL of water and 6.0 mL conc. HCl. One of the tubes was heated in boiling water for 30 min and then cooled protected from light. The other tube was maintained at room temperature. In each tube 1.0 mL of ethanol was added and absorbance was measured at 550 nm. The difference of absorbance between the heated and the unheated tubes was related to tannin concentration (g/L). For both analyses, absorbance measures were performed in an Spectronic Genesys 2 UV–Visible spectrophotometer (Spectronic Instruments, Rochester, NY).

Table 1
Characteristics of the Uruguayan Tannat wine samples considered in the study.

Sample	Vintage	Aged in oak barrel	Price (US$)	Ethanol (%)	Total acidity (g/L)	Total polyphenol index	Tannins (g/L)
1	2014	No	7	$12.2^{b,c}$	4.97^{b}	50.8^{a}	2.43^{a}
2	2012	No	6	12.3^{c}	4.85^{a}	66.2^{b}	3.85^{b}
3	2013	No	7	11.8^{a}	5.13^{c}	57.8^{a}	2.74^{a}
4	2012	No	14	14.4^{e}	4.97^{b}	98.7^{d}	5.06^{c}
5	2006	Yes	43	12.9^{d}	5.52^{e}	81.6^{c}	5.05^{c}
6	2012	No	17	12.9^{d}	4.96^{b}	52.3^{a}	2.88^{a}
7	2013	Yes	13	$11.9^{a,b}$	5.31^{d}	117.4^{e}	6.56^{d}

Average values within a column with different superscripts are significantly different according to Tukey's test ($p < 0.05$).

2.2. Trained assessor panel

The sensory panel consisted of nine assessors (7 females), ages ranging from 26 to 50 years old. Assessors were selected according to the guidelines of the ISO 8586:2012 standard (ISO, 2012).

Assessors had 18 month experience in astringency evaluation using unstructured line scales and time intensity methodology. Astringency was defined as the "tactile sensation felt in mouth and characterized by dryness and roughness". Assessors had been trained to differentiate between astringency, bitterness and sourness by evaluating reference standards (5.0 g/L alum, 1.5 g/L citric acid and 0.8 g/L caffeine solutions, respectively). The 5.0 g/L alum solution was considered as the reference for "high" astringency. The evaluation protocol required assessors to take a sip (15 mL) in their mouth, to swish the sample gently for 10 s while performing a standardized vertical tongue movement. Then, assessors were asked to spit the sample.

Assessors were also trained to describe astringency using check-all-that-apply questions involving a list of 16 terms, of which 12 were included in the Mouthfeel wheel (Gawel et al., 2000), during a total of twelve 15-minute sessions. Six additional 15 minute training sessions were considered to introduce assessors to the notion of Temporal Dominance of Sensations, as well as to allow familiarization with the software used for data collection.

2.3. Experimental procedure

The protocol for sample evaluation was based on the recommendations provided by Lee and Vickers (2010). Assessors were asked to click on the start button of the software and to simultaneously take a sip of palate cleanser in their mouth. After 20 s they had to take a sip of still mineral water. Then, after 40 s they had to take a sip of a sample (15 mL) and to start the TDS task. The evaluation protocol required assessors to take a sip (15 mL) in their mouth, to swish the sample gently for 10 s while performing a standardized vertical tongue movement. Then, assessors were asked to spit the sample and to continue the evaluation for additional 30 s. The timeline for sample evaluation is shown in Fig. 1.

During the TDS task, which lasted a total of 40 s, assessors had to continuously select the dominant astringent characteristic at each moment of the evaluation from a list of 8 terms. A dominant characteristic was defined as the one that caught most of the attention at a given moment, not necessarily being the most intense. The eight terms included in the list were: 'dry', 'fine emery', 'harsh', 'mouthcoating', 'puckery', 'rough', 'silky', and 'velvety'. To avoid list order bias, the order of the attributes was different for each assessor, following Williams' Latin square design. The terms of the list were selected by open discussion with the panel leader, in a session in which the assessors were presented with 10 different samples of Tannat which had been previously evaluated by the panel using static methods (check-all-that-apply questions). The definition of the terms and the references used during training is shown in Table 2.

After the TDS task, assessors were asked to rate the maximum astringency intensity perceived during the evaluation using a line scale, ranging from 0 = nil to 10 = high.