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Analytical Methods

Training of panellists for the sensory control of bottled natural mineral water in connection with water chemical properties

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ABSTRACT

As bottled mineral water market is increasing in the world (especially in emergent and developed countries), the development of a simple protocol to train a panel to evaluate sensory properties would be a useful tool for natural drinking water industry. A sensory protocol was developed to evaluate bottled natural mineral water (17 still and 10 carbonated trademarks). The tasting questionnaire included 13 attributes for still water plus overall impression and they were sorted by: colour hues, transparency and brightness, odour/aroma and taste/flavour/texture and 2 more for carbonated waters (bubbles and effervescence). The training lasted two months with, at least, 10 sessions, was adequate to evaluate bottled natural mineral water. To confirm the efficiency of the sensory training procedure two sensory groups formed the whole panel. One trained panel (6 persons) and one professional panel (6 sommeliers) and both participated simultaneously in the water tasting evaluation of 3 sample lots. Similar average scores obtained from trained and professional judges, with the same water trademarks, confirmed the usefulness of the training protocol. The differences obtained for trained panel in the first lot confirm the necessity to train always before a sensory procedure. A sensory water wheel is proposed to guide the training in bottled mineral water used for drinking, in connection with their chemical mineral content.

1. Introduction

The World Health Organisation recommends a daily consumption of water of around two litres a day for an adult. In Europe, packaged water sales account for 44% of the market of non-alcoholic drinks, in volume; and naturally sourced waters (natural mineral water and spring waters) represent 97% of the market volume (European Federation of Bottled Water, 2012). In 2011 the total volume of bottled water consumed in the United States increased 4.1% compared to 2010 and bottled water added more gallons to its per-person consumption rate in 10 years than either ready-to-drink tea or sports beverages reached by the end of that period (International Bottled Water Association., 2012). In fact, bottled mineral water is an important sector in some countries as Spanish soft drinks market, increased by 67% in the last decade (Huete-Machado, 2010). The Food and Drug Administration requires that "mineral waters" contain between 500 and 1500 mg/L of total dissolved solids, a combination of dissolved minerals. In Europe, however, water with any level of mineralisation is considered "mineral water" (Azoulay, Garzon, & Eisenberg, 2001).

World Health Organization is also concern on sensory water aspects and in the guidelines for drinking water quality is recently reported that the provision of drinking-water is not only safe but also acceptable in appearance, taste and odour (WHO, 2011). In addition, European legislation established that the natural mineral water may not contain any organoleptic defects (Directive 2009/54) that could come from materials and articles intended to come into contact with foods (Regulation, 1935/2004). Without considering the health benefits, water quality consumer complaints are triggered by changes in sensory properties (Whelton, Dietrich, Burlingame, Schechs, & Duncan, 2007), mainly taste and odour (Bae, Shin, & Choi, 2007). Some authors reported that sensory characteristics are very important perceptions for the quality of drinking water (Gray, 2008; Jones et al., 2006) and are also considered aesthetic relevant factors when choosing drinking water (Dietrich, 2006). The first sensory studies concerning water samples, implemented in the mid-80s, were mainly focused on taste and odour identification (Mallevialle & Suffet, 1995) and off-flavour detection (Krasner, 1988). These and other publications based on Flavour Profile Analysis (Fabrellas & Devesa, 2003; Krasner, Mcguire, &

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Ferguson, 1985; Suffet, Brady, & Bartels, 1988) contributed to establish sensory standard methods to characterise water (APHA, 2005). Other standards were focused on determination of odour and flavour thresholds (AWWA, 2002; UNE-EN 1622, 2007). As result of the works developed in sensory and chemical properties of water, some water wheels were published (Devesa et al., 2004; Ferreira Filho & Alves, 2006; Suffet, Schweitzer, & Khiari, 2004), but all of them are related to supply waters. As far as we know none mineral drinking water wheel has been yet published.

Analytical methods used to analyse molecules related to taste and odours in drinking water require specialized and costly equipment (Proulx, Rodríguez, & Sérodes, 2010). It is not easy and cheap to combine these techniques at the same time as tasting procedures. Moreover, the economic crisis has reduced the funding for research projects in countries as Spain (Pain, 2012). In addition, some authors have reported that the human senses are sometimes more sensitive than the best available analytical equipments (Devesa et al., 2004) and other authors have recently review some sensory methodologies used in water (Teillet, Schlich, Urbano, Cordelle, & Guichard, 2010). There are lots of scientific papers on the sensory evaluation of wines (González-Barreiro, Rial-Otero, Cancho-Grande, & Simal-Gándara, 2013; González-Álvarez, González-Barreiro, Cancho-Grande, & Simal-Gándara, 2011; González-Álvarez, González-Barreiro, Cancho-Grande, & Simal-Gándara, 2012a; González-Álvarez, González-Barreiro, Cancho-Grande, & Simal-Gándara, 2012b; González-Álvarez, Noguerol-Pato, González-Barreiro, Cancho-Grande, & Simal-Gándara, 2013; Noguerol-Pato, González-Álvarez, González-Barreiro, Cancho-Grande, & Simal-Gándara, 2012; Reboredo-Rodríguez, González-Barreiro, Cancho-Grande, & Simal-Gándara, 2013), but a rather limited number in the field of mineral water sensory properties (Sipos, 2011; Teillet, Urbano, Cordelle, & Schlich, 2010). Therefore, the purpose of this work was the development of a simple protocol to determine sensory properties in bottled mineral waters (still and sparkling) using few trained panellist (6 persons). Moreover, in order to confirm the efficiency of the protocol, the results obtained by using the trained panellists were compared with the information reported by professional judges (6 persons). The training, performed just before the tasting evaluation, improved the efficiency in the developed sensory test. Sensory evaluation of the waters was also correlated with their physicochemical parameters by partial least square regression.

2. Materials and methods

2.1. Water samples

Three groups of natural mineral waters (27 samples), bottled in glass or in plastic packages, were assayed in 2007. They were classified following European legislation (Directive 2009/54) adopted by Spanish legal requirement (Real Decreto 1789/2010) as: waters of very low mineral content with dry residue <50 mg/L (3 trade marks), low mineral content with dry residue range 50–500 mg/L (14 trade marks) and carbonated waters with >600 mg/L HCO_3^- or >0.250 g/L CO_2 (10 trade marks). To test the effectiveness of the training protocol, the same trademarks and water types (15 samples per lot) were selected and considered for this study in 3 different lots: 2 waters of very low mineral content, 6 of low mineral content and 7 carbonated mineral waters. These waters were evaluated simultaneously in 3 sessions by the two panels (trained and professional). Table 1A resumes water type, package and labelled mineral contents. Glasses cups of same shape and size, previously washed and dried, were used for sensory evaluations. All sample waters were served for sensory sessions at 12–15 °C, being the average time period of global evaluation for each water sample between 10 and 15 min.

2.2. Training protocol

In this study 10 questionnaires were used (see Supplementary files), one for judges recruitment (questionnaire 0) and seven for training, with questions related to water appearance (questionnaire 1), odour classification and identification (questionnaires 2 and 3), taste test (questionnaires 4 and 5), mineralisation test (questionnaire 6) and gas content detected in mouth for sparkling waters (questionnaire 7). Moreover, 2 questionnaires were set for the global sensory water evaluation (one for two categories of still waters and other for carbonated waters) (questionnaires 8 and 9).

2.3. Appearance descriptors

To evaluate hues in mineral waters, dye materials (used to paint) were prepared by dilution in distilled water. Colours used for training (tempera gouache from Reeves) were green (light green), yellow (primary yellow), red (brilliant red), blue (blue lake), white and black. Also soil plant, qualified as very dark brown 7.5YR 2.5/2, following criteria in Munsell colour scale (Munsell Colour Co., 1998) was used to prepare a colour standard solution. Every colour was weighed and diluted with distilled water to obtain a very pale colour.

In the corresponding questionnaire the panellists marked the observed colour in the dilution solutions (intensity ranged 0–10). Attributes considered to be also marked by panellist were: Orange and brown colour. Other appearance attributes were used: transparency and brightness (evaluated as a whole), opalescence, turbidity and bubbles. Fizziness was only evaluated in mineral carbonated waters (sparkling waters) considering word “bubbles”, as a sight attribute, and effervescent texture as detected in mouth. To evaluate the intensity of fizziness, two soda beverages (one soda and soda solution diluted to half in mineral water) were used to train in bubbles detection. Size and number of bubbles were evaluated in the effervescence test.

2.4. Odour/aroma descriptors

Criteria established in literature, to train panellists to evaluate odour and flavour in water, were applied (ISO 5496, 2006; Sancho, Bota, & de Castro, 1999; Suffet et al., 2004). Compounds and reagents recommended by these sources, and others included by us, were used to determine odour/flavour descriptors by the trained panellists, by weighing (solid substances) or pipetting (liquid). Distilled water and ethanol were used to prepare diluted aroma solutions (Table 1B). The grouped odour families match with works reported by other authors for water supply (Ferreira Filho & Alves, 2006). The stock solutions for the standards were weekly prepared and stored at 4 °C and the dilutions were daily prepared, just before sensory evaluation aroma tests.

These diluted solutions were smelled by panellists and they had to identify family odour, compound and/or similar descriptor. Judges were asked to open each odour flask and inspire the content. Once done with one flask they should wait at least one minute and continue with the rest of odour flasks. It is convenient not to return to previous flask in order to avoid odour saturation. Some chemicals as chlorine or geosmine have shown to cause panellist fatigue, therefore panel rest periods between samples were needed (Krasner, McGuire, & Ferguson, 1983).

It has been known for a long time water of its own nature has no flavour (de Greef, Zoeteman, van Oers, Köster, & Rook, 1983). And, as mineral waters have weak flavour, the parameters considered to be included in the tasting sheet detected by nose were three: pleasant/unpleasant sensation in perceived overall aroma and the odourless.