Preliminary test of a uniform colour scale for virgin olive oils

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ABSTRACT

A new set of 184 virgin olive oil samples from Italy and Spain has been used to test the performance of two specific colour scales: BTB and UOCS. In agreement with previous tests, the UOCS performed about twice as well as did the BTB, the difference between these two scales being statistically significant ($P<0.001$), both for Italian and Spanish samples. With respect to UOCS standards, the oils from the two countries seem to be slightly different ($P=0.059$ in CIELAB colour space). Although this fact should be attributed to the wider range covered by the Spanish oil samples in CIELAB space, further study with a greater number of colour samples seems to be advisable.

1. INTRODUCTION

Colour is generally considered an important property of virgin olive oils, because it is immediately perceived and strongly influences most customer preferences. The bromthymol blue (BTB) method[1,2] is the official method for colour specification of virgin olive oils currently used in Spain, the world leader in production of this product. This method is based on a visual comparison between an oil sample and a given set of 60 standard solutions (BTB standards), seeking the one most closely matching the colour of the oil sample.

Different flaws in the BTB method have been reported in the literature[3,4], leading to the recent proposal of a new colour scale[5], called the Uniform Oil Colour Scale (UOCS), because it is based on a regular rhombohedral lattice analogous to the one used by the Uniform Colour Scales of the Optical Society of America[6]. Like the BTB method, the UOCS method also proposes a set of 60 colours (UOCS standards), which are more uniformly and appropriately distributed in colour space than the previous BTB standards[5]. These UOCS standards have been developed from a given set of 1700 samples of virgin olive oils, which were extracted in the laboratory of Almazara Experimental del Instituto de la Grasa (CSIC, Seville, Spain)[7] by the Abencor® method[8]. Using these 1700 samples, it has been found that UOCS improved BTB, for virgin olive oils from olives with three different stages of ripeness, eight different varieties, and four harvest seasons, all these improvements being statistically significant[9].

Both BTB and UOCS method provide a useful set of standards for colour classification of virgin olive oils. This classification can be made by direct visual comparison (under specified visual conditions), or by colour measurements of oil samples and subsequent search of the nearest standard. The main goal of the current work is to perform a preliminary test comparing the BTB and UOCS methods for a new set of virgin olive oil samples different from the 1700 samples[7] used in our previous tests[5, 9], and for the construction of the UOCS standards.

2. METHOD

We have used a new set of 184 samples of virgin olive oil, from two different countries: 86 samples from Italy, and 98 from Spain. All our virgin olive oil samples were filtered, and their spectral absorbance (380-770 nm, $\Delta\lambda=2$ nm) was measured using a Hewlett Packard 8452 ultraviolet-visible light diode array spectrophotometer, with quartz cells of 5 mm pathlength. Measured values were referred to 10 mm pathlength and used to compute tristimulus values, assuming D65 illuminant and CIE 1964 Supplementary Standard Observer[10]. These tristimulus values were transformed to

CIELAB assuming an n-hexane solution as reference white. The CIELAB coordinates of the BTB and UOCS standards were computed using analogous assumptions[5].

The CIELAB and DIN99d[11] colour differences between each of the 184 oil samples and its nearest standard from both BTB and UOCS scales were computed. Low values of these colour differences indicate good performance of the colour scales. We have used DIN99d colour space in the current work because it is a quite uniform Euclidean space, which was also employed for the development of UOCS. The colour differences were analysed using nonparametric statistical tests (Wilcoxon test for related samples, and Mann-Whitney test for unrelated samples) available in SPSS 12.0.1 software[12].

3. RESULTS

Figure 1 shows the CIELAB colour coordinates of the 184 virgin olive oils used in our study, distinguishing Italian and Spanish samples. Although the samples from the two countries are spread over a similar region of CIELAB colour space, Figure 1 reveals that the range covered by the Spanish samples is slightly wider than the one corresponding to the Italian ones, in particular for the L^* and a^* coordinates. In addition, it can be noted that the current 184 virgin olive oil samples are within the range covered by the 1700 oil samples used for the development of UOCS[7]: $-15.0 < a^* < 10.0$; $12.0 < b^* < 134.6$; $49.9 < L^* < 99.3$. The range covered by the UOCS standards (not shown in Figure 1) is: $-6.9 < a^* < 9.0$; $24.3 < b^* < 119.9$; $75.5 < L^* < 97.3$.

Figure 2 shows the colour differences (average and standard deviation) between the set of 184 oil samples used here and their nearest BTB and UOCS standards, both in CIELAB and DIN99d colour spaces. From the average colour difference in CIELAB units, UOCS performs about 2.2 times better than BTB. In CIELAB the standard deviation of the colour differences is 2.8 times higher for BTB than for UOCS. These results agree very well with the ones reported during the development of UOCS from 1700 samples virgin olive oils from Spain[5]: In this latter case, the average colour differences in CIELAB units indicated that UOCS performed 2.0 times better than BTB, and the standard deviation was 2.2 times lower for UOCS than for BTB. From the distances between oil samples and standards, both in CIELAB and in DIN99d space, the Wilcoxon test indicated that UOCS is statistically significant different than BTB ($P<0.001$) for the whole set of 184 oil samples, as well as for the Spanish and Italian subsets.

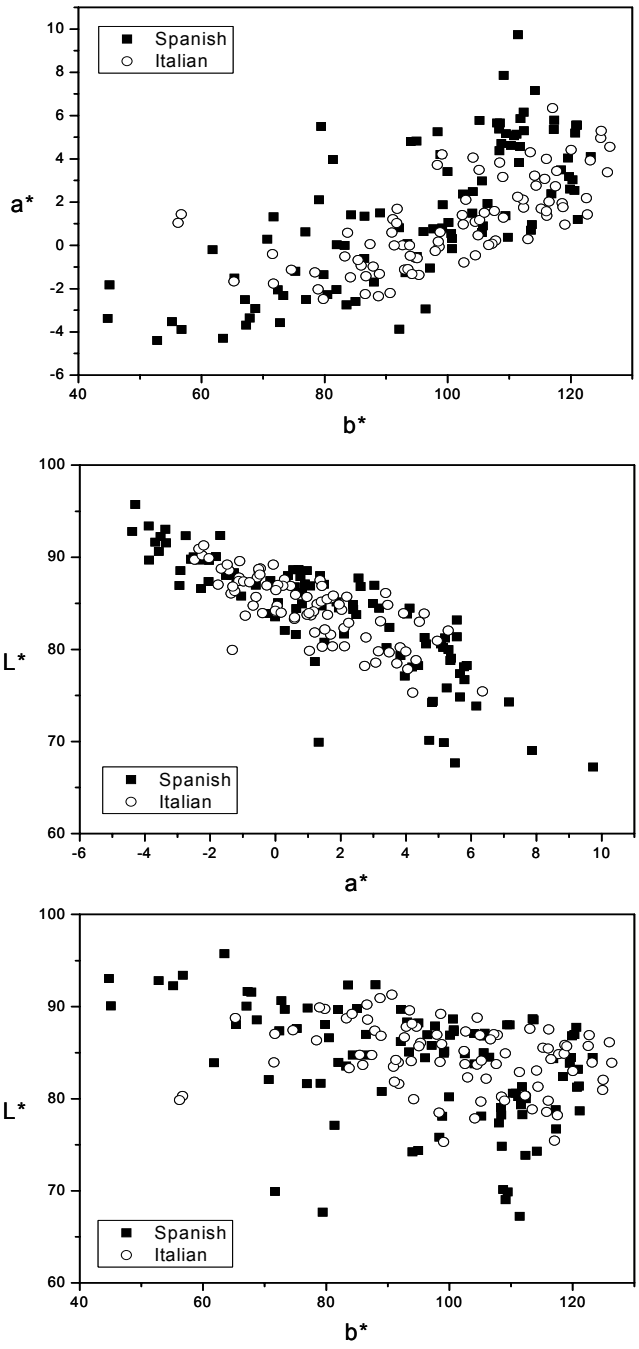

Figure 1: CIELAB colour coordinates of the 184 virgin olive oil samples studied, distinguishing Italian (86) and Spanish (98) samples.

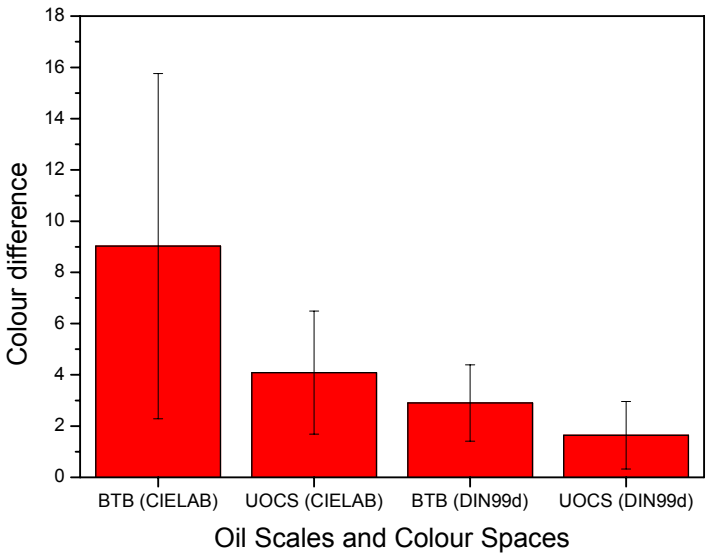

Figure 2: Colour differences using CIELAB (left) and DICN99d (right) units, from 184 virgin olive oil samples to their nearest BTB and UOCS standards. Average values are shown, with standard deviation denoted by error bars.

Figure 3 shows a comparison of the results found for Italian and Spanish virgin olive oils. The improvement of UOCS upon BTB is again evident for the samples from the two countries. The average CIELAB and DIN99d colour-differences seem to be quite similar for Italian and Spanish oil samples. The Mann-Whitney test indicated that, with respect to BTB standards, the difference between Italian and Spanish oils was not statistically significant (P=0.870 in CIELAB and P=0.740 in DIN99d). However, with respect to the UOCS standards the Mann-Whitney test indicated stronger differences between Italian and Spanish oils (P=0.059 in CIELAB and P<0.001 in DIN99d). This last fact appears to be related to the difference in the distribution of the Italian and Spanish oils shown in Figure 1, and requires further study.

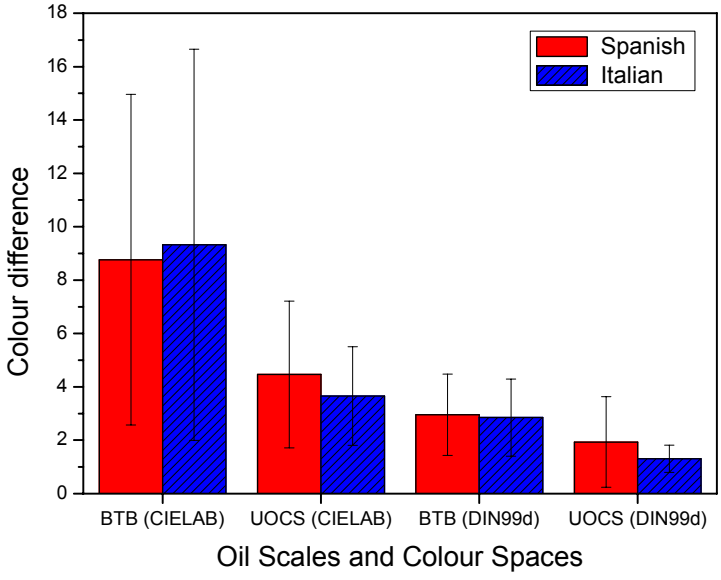

Figure 3: Colour differences using CIELAB (left) and DIN99d (right) units, from oil samples to their nearest BTB and UOCS standards. Italian (86) and Spanish (98) oil samples are distinguished. Average values are shown, with standard deviation denoted by error bars.

4. CONCLUSION

The results shown in this preliminary test are encouraging with respect to the good performance of the UOCS scale. Currently, additional virgin olive oil samples from different manufacturers and countries are being collected, in order to study the performance of the UOCS with a greater number of samples. It is intended that in a next future the UOCS can be proposed for international adoption in colour specification of virgin olive oils.

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