



## Comparison between Color Spaces of Vita Lumin Shade Guide with Natural Teeth in Bengaluru Population using Spectrocolorimeter: An *in vivo* Study

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### ABSTRACT

**Aim:** The aim of this study is to compare the color space of Vita Lumin shade guide (SG) with the natural teeth of the local population.

**Materials and methods:** A total of 100 maxillary central incisors (100 patients) were subjected to color measurement with a spectrocolorimeter. For each tooth, L\*, a\*, b\* values were recorded. All the shade tabs of Vita Lumin SG were analyzed with a spectrocolorimeter to define the color space covered by the Vita Lumin SG. The L\*a\*b\* values of natural teeth were plotted on separate scattered diagrams and compared.

**Results:** About two out of three attributes (luminance and blue spectrum) of the local population of Bengaluru displayed a broader range than those available in Vita Lumin SG.

**Conclusion:** The local population requires an SG with an extended range, covering a higher luminance spectrum and broader blue spectrum.

**Clinical significance:** Esthetic restorations require accurate shade matching with the adjacent natural teeth, SGs being the mean of shade selection and communication should be comparable to the natural teeth.

**Keywords:** Color, Luminance, Spectrocolorimeter, Visible spectrum, Vita Lumin shade guide.

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### INTRODUCTION

Shade matching of the restoration is a challenging task of esthetic dentistry. Since the natural tooth has wide range of shade, achieving an accurate shade match of a restoration is a complicated process.<sup>1</sup> Clinicians should have an understanding of light and its parameters as well as should be able to communicate the accurate shade to the laboratory technicians.<sup>2,3</sup>

Color has been related more to art than science, as a result of which color measurement is difficult. However, there have been various attempts to find a common ground between color and science.<sup>4</sup>

In 1931, Clark introduced a custom-made SG after recognizing the requirement of a more systematic approach, the basis of which was visual analysis of natural teeth, recorded in the Munsell color system. In spite of being a relatively good method, its use was cumbersome.<sup>5</sup>

At the same time, standards of shade matching were published by [Commission Internationale de l'Eclairage (CIE) or the International Commission on Illumination] setting the parameters for shade assessment.<sup>6</sup>

In the 1970s, Sproull<sup>7</sup> suggested a similar SG based on Munsell color system, which had color tabs logically arranged in color space.

In 1974, a spectrophotometer was used by Lemire and Burk<sup>8</sup> for the first time to investigate the distribution and frequency of natural tooth color space. They concluded that the natural teeth had wider color space than the SG. Preston<sup>9</sup> identified various problems with SG, such as the influence of gingiva during shade selection, and the difference in material of shade tabs and ceramics. A survey

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Fig. 1: Spectrocolorimeter- X-Rite RM200QC



Fig. 2: Crosshair focussed on middle third of central incisor

done by Goodkind and Loupe<sup>10</sup> reported that all the shades of natural tooth should be included in SG. In 1990, Miller<sup>11</sup> stated that the SG and restoration material and thickness should be similar. The first SG for measuring color ceramic systems was by Vita Zahnfabrik in the year 1956. Although still imperfect, it introduced some visual parameters that are used even today, with some minor modifications. In Vitapan Classical SG, 16 shade tabs are present, which are arranged in four groups based on hue and further subdivided within the groups according to the increasing chroma.<sup>12</sup>

A significant factor that contributes to the dissatisfaction of clinicians, technicians, and patients is the limited spectrum of commercially available SG.<sup>13</sup> Hence, a study was designed to evaluate the color space of the anterior teeth of the local population of Bengaluru and compare it with the Vita Lumin SG.

## MATERIALS AND METHODS

This study was conducted at the Department of Prosthodontics, KLE Society's Institute of Dental Sciences, Bengaluru, India. Approval was obtained from the Institutional Ethical Committee, for the study protocol and informed consent forms (KIDS/IEC/11-2014/24).

Inclusion criteria for this study were: Vital maxillary central incisor, willingness to sign the consent form. Exclusion criteria were: Subjects with carious lesions, congenital anomalies, intrinsic/extrinsic stains, fractured, malaligned, and bleached teeth.

A total of 100 subjects, in the age group of 20 to 40 years and both sexes, were selected randomly and allocated to this study after recording case history.

For color measurement, a portable imaging spectrocolorimeter X-rite RM200QC (Fig. 1) was used in this study.

The middle third of the maxillary central incisor was used as the experimental unit for this study, due to the

uniformity of shade in this region (Fig. 2).<sup>13</sup> The middle area of the tooth is flat, reflecting light with less influence from the overlying layer of enamel. The tooth was cleaned with pumice slurry, to remove any plaque or other debris, and subjected to color measurement. Vita Lumin Vacuum SG was chosen as the control for this study. The crosshairs in the spectrocolorimeter were focused on the middle third of the tooth/shade tab respectively, to obtain color readings (Fig. 3).

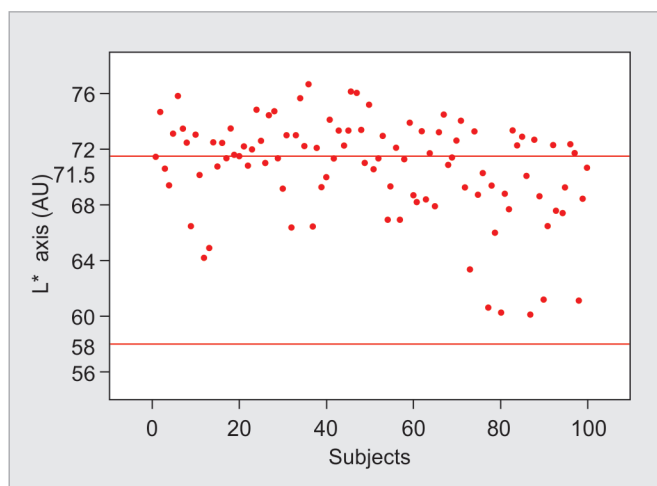
The values for the control group and all 100 samples of test group were obtained in the CIE L\*a\*b\* system. After obtaining the data from the SG and subjects, the values were plotted on a scatter diagram to show the range of shades covered by the Vita Lumin guide and test group respectively.

## RESULTS

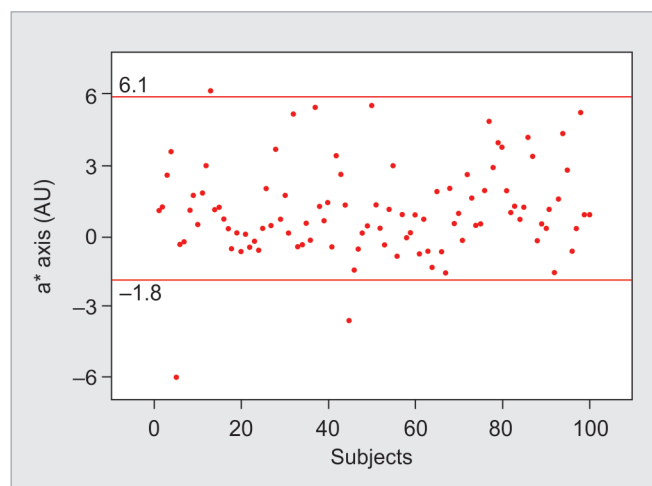
The comparison between control group and subjects was done for luminance ( $L^*$ ), red-green ( $a^*$ ), and blue-yellow ( $b^*$ ) on independent scatter plots (Graphs 1–3).



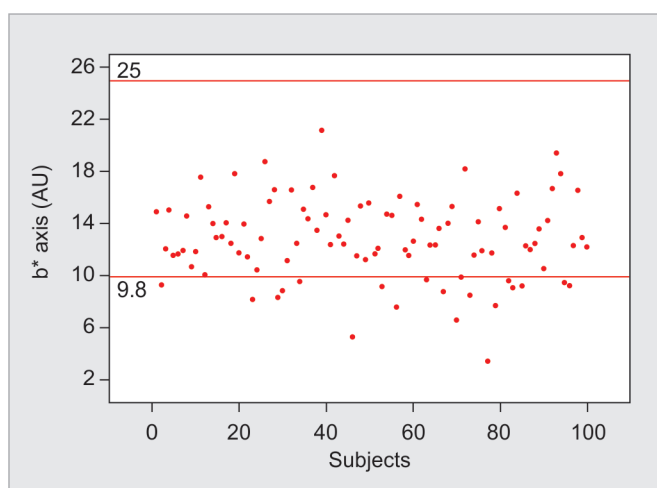
Fig. 3: Measurement of color values



Graph 1: Luminance values (L\*)



Graph 2: Red-green values (a\*)



Graph 3: Blue-yellow values (b\*)

Only 53 subjects reported luminance values that were within the range of the Vita Classic SG; 47 subjects reported values that were higher than the range covered by Vita Classic SG.

A total of 97 subjects reported red-green values that were within the range of the Vita Classic SG. Only three subjects reported values that were outside the range covered by Vita Classic SG.

A total of 80 subjects reported blue-yellow values that were within the range of the Vita Classic SG; 20 subjects reported values that were outside the range covered by Vita Classic SG.

It is evident here that, in terms of luminance and blue-yellow values, the Vita Classical SG does not extend into the entire spectrum of shades required for the given population.

## DISCUSSION

In spite of the commercial availability of various SGs, the Vita Lumin Vacuum is one of the most commonly used

SG in Bengaluru.<sup>14</sup> Ease of use and extensive laboratory support for this SG has made it very popular. However, the color space covered by this SG is not enough to meet the high esthetic demands of both the dentists and patients alike.

This study was carried out to analyze the deficiency in the color space required to match the teeth shades of the local population.

Measurement of color is a complex process, as it involves analyzing the interaction between the object and light source. Due to its complex nature, precise measurement of color requires the understanding of the three-dimensional (3D) nature of color. Interpretation of color data was simplified by the CIE L\*a\*b\* (CIELAB) system and is now used as the universal system for colorimetry.<sup>15</sup>

The CIELAB color space is a derivation of color space from the values of X, Y, Z, with L\*, a\*, and b\* coordinates (Fig. 4). The international standard for color specification system uses it for colorimetric analysis of teeth and restoration. The L\* axis is the lightness or darkness, ranging from white (100) to black (0). The a\* axis is red (+a\*) to green (-a\*), and the b\* axis is yellow (+b\*) to blue (-b\*).

Measurement of color is done using a spectrophotometer or spectrophotometer. Using a spectrophotometer for measuring tooth color is cumbersome, owing to the large size of the equipment.<sup>13</sup> Hence, a portable spectrophotometer was used in this study.

The results of the present study are in accordance with previous studies proving the inadequacy of Vita Lumin SG, in terms of shade distribution.<sup>1,2,16</sup> Guan et al<sup>17</sup> conducted a similar study comparing the CIE of Vita Lumin SG to natural teeth and concluded that spectrophotometry underestimated the CIE value index. Raghunathan et al<sup>18</sup> in their review article cited many studies done to compare the various SG system to natural teeth using different techniques, namely, digital, spectrophotometer, spectrophotometer, etc., and concluded that influence



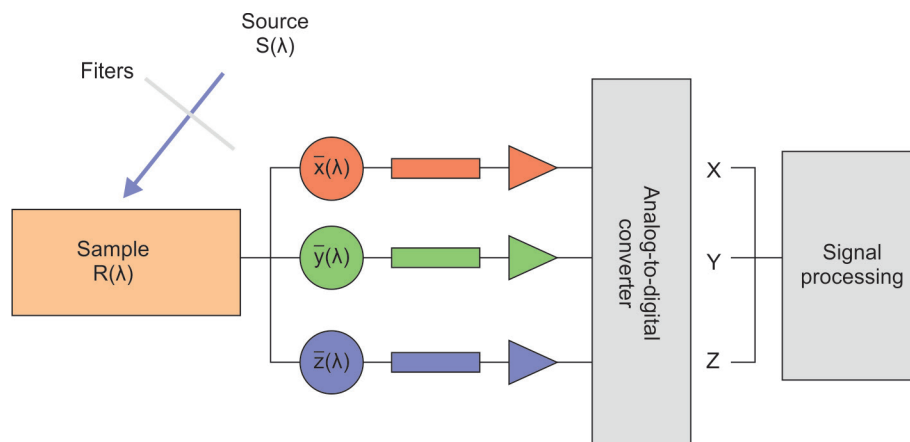


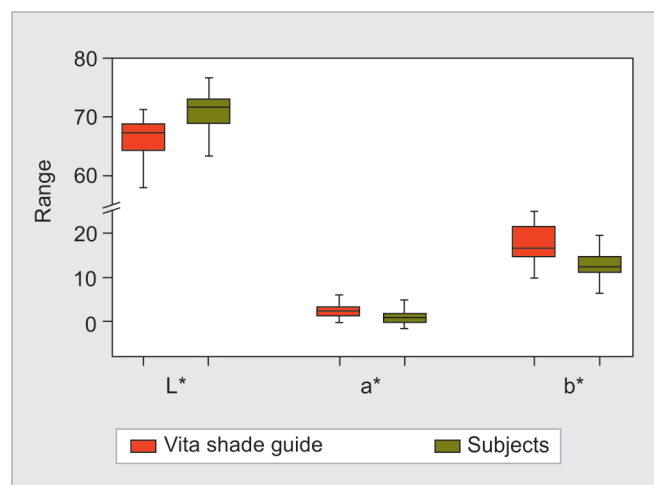
Fig. 4: Working principle of Spectrocolorimeter

of illuminants on SG should be considered while doing shade matching. Hasegawa et al<sup>13</sup> conducted a study to evaluate translucency of natural dentition for all age groups and the difference of the color and translucency between natural dentition and Vita Lumin SG. The results showed that the Vita SG revealed less lightness, compared with the natural tooth, and the differences in redness and translucency between Vita SG and the natural tooth tend to increase near the root. In particular, the red-green chromaticity of Vita SG was not distributed to cover the natural tooth for all age groups; Yuan et al<sup>14</sup> conducted a study to define a natural tooth color space within the Greater Buffalo, New York, population and compared that to the color space determined by a manufacturer. Although there was a strong relationship between Buffalo, NY, measurements (BUF) and Vita 3D-Master SG values (REF), color differences between BUF and REF were frequently above published perceptibility thresholds ( $\Delta E^* = 1.0\text{--}3.7$ ). Schwabacher and Goodkind<sup>16</sup> compared 3D color coordinates of natural teeth with three SG, the SG studied did not match the space of vital teeth at the middle facial surface. In accordance with previously published measurements, deficiencies were noted in the yellow-red spectrum and value of the shade guide. Brewer et al<sup>1</sup> summarized that optical properties, such as translucency, light scattering, surface texture, and gloss are important to a successful restorative match.

The positive shift (from the range of values covered by Vita Lumin) reported in this study is indicative of Vita Lumin SG not extending enough on the luminance (value) scale (Graph 1).

However, in the red-green spectrum, the Vita Lumin SG managed to extend enough to cover almost all the samples (Graph 2).

The negative shift (from the range of values covered by Vita Lumin) reported in the blue-yellow scale is indicative of Vita Lumin SG not extending enough in the blue spectrum (Graph 3).



Graph 4: Comparison of luminance (L\*), red-green (a\*), and blue-yellow (b\*)

Based on the observation of this study, it suggests that the Vita Lumin SG does not mimic the color space of the dentition of the local population under study. However, it does not indicate that Vita Lumin is totally unacceptable (Graph 4) since the threshold for perceptibility of the human eye is lower than the threshold for acceptability of the shade.<sup>3,19</sup>

Limitations of this study are the measuring instruments as well as the size and age group chosen for the selected population. Furthermore, no newer SG systems have been considered in this study. There is further scope for this study, to include a larger population under study and define a color space that would cover the entire spectrum, to provide highly precise SG to cater for today's esthetic demands.

## CONCLUSION

Within the limitations of this study, the following conclusions were drawn:

- The luminance range of the Vita Lumin SG is not extending till the range required for the local population

- The blue spectrum of the Vita Lumin SG falls short in covering the range required for the local population.

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