

Three - dimensional color coordinates of natural teeth in a sample of young Saudis: A pilot study

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هدفت هذه الدراسة إلى تحديد الأبعاد الثلاثية لعوامل اللون الخاصة بأسنان عينة من سعوديين يافعين. شارك في هذه الدراسة ١٠٠ طالب وطالبة من كلية طب الأسنان، جامعة الملك سعود. ولقد تم إختيار احد القواطع العلوية السليمة من كل طالب او طالبة لقياس عوامل اللون في الجزء الأوسط منها. ثم تم قياس كل سن بواسطة السبكتروفوتوميتر (أداة قياس شدة الضوء بين مختلف أجزاء الطيف)، و تحديد عوامل اللون في نظام (CIELAB) ومن ثم تمت مقارنة عوامل اللون (L^*, a^*, b^*) الخاصة بالطلاب بتلك الخاصة بالطالبات. اظهرت النتائج انه لم يكن هناك فوارق في درجة سطوع اللون بين أسنان الطلبة والطالبات. إلا أن أسنان الطالبات كان اللون فيها أقل تشبعاً مقارنة بأسنان الطلبة.

The objective of this *in vivo* study was to determine the three dimensional color coordinates of teeth in a sample of young Saudi subjects. One hundred male and female Saudi dental students in the College of Dentistry at King Saud University participated in this study. For each subject, the color measurements were performed for the middle third of one maxillary central incisor. The VITA Easyshade spectrophotometer was used to determine the CIELAB color coordinates (L^* , a^* , b^*). The L^* , a^* , b^* values of male and female subjects were compared. Results showed that there was no statistically significant difference in lightness (L^*) of the male and female teeth. On the other hand, female teeth appeared to be less saturated (less a^* and b^*).

INTRODUCTION

Harmonious color matching of a restoration or prosthesis to the remaining dentition, particularly in the anterior region, is of primary concern to dental patients.¹ Accurate determination of the natural teeth color range is essential to the manufacturing of tooth color restorative materials and shade guides that match different natural dental shades.

Traditionally, the dental profession has described the color of teeth in terms of Munsell color parameters namely: hue, value and chroma. However, in order to be able to facilitate the quantification of color differences, the L^* a^* b^* color system was developed by the Commission Internationale de l'Eclairage (CIE) which is the International Commission on Illumination. The three parameters (coordinates) to define color are L^* , a^* and b^* . The L^* coordinate correlates to Munsell value which described the level of

grayness of a color along the black – white axis. The a^* coordinate describes the color in reference to the red - green axis and the b^* coordinate relates to the yellow – blue axis. Therefore, the a^* and b^* coordinates describe the chromatic component of the color.²⁻⁴

The ranges of natural teeth color have been reported by various investigators.⁵⁻⁸ The data of these studies were obtained from both *in vitro* and *in vivo* measurements. These studies demonstrated the disharmony between the colors of available dental porcelain and dental shade guides on one hand, and the color ranges of natural teeth on the other.^{2,8,9} At the present time, there appears to be no published data about the ranges of natural teeth color of the Saudi population.

The objective of this study was to provide baseline information regarding the distribution of natural teeth of young Saudi male and female subjects, in the color space, using the CIE L^* a^* b^* color system.

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MATERIALS AND METHODS

A randomly selected sample of one hundred Saudi dental students (50 males and 50 females) from the College of Dentistry, King Saud University, Riyadh, Saudi Arabia, participated in this study. Their ages ranged between 20 and 24 years. Exclusion criteria in the study were: (1) the presence of any restoration, veneer or crown in both maxillary central incisors, (2) endodontic treatment in both maxillary central incisors. Polishing was performed on each subject's maxillary anterior teeth prior to making the color measurement. Color measurements were performed at the middle third of a sound and vital maxillary central incisor.

VITA Easyshade (VES) intraoral spectrophotometer (VITA Zahnfabrik, Bad Säckingen, Germany) was used for measuring the teeth color. The VITA Easyshade consists of a base unit and hand piece connected by PVC stainless steel monocoil fiber optic cable. The hand piece contains probe assembly for illuminating and receiving light from a tooth, multiple spectrometers and microprocessors for communication with the base unit. VES uses the D65 (6,500°k) illuminant for shade matching. The geometry of the Easyshade probe is a pseudo 0/0 circular design. The probe illuminates a 5 mm diameter area on the tooth surface.

Cross infection was controlled by using the manufacturer recommended polyurethane infection control shield for each subject. It is a form of pouch that is stretched over the end of the probe. Calibration of the VES was performed after applying the shield. To measure the shade of the middle third of each tooth, the probe tip was held 90° in contact with the tooth surface then the measurement button was depressed. VITA Easyshade base unit displays the results of the measurement as it relates to either the

Vita classic shade guide system or the 3D – Master shade guide system. Additional information about the CIE LAB color parameters (L^* , a^* , b^*) could be obtained from the instrument. For each tooth, three consecutive measurements were recorded and the average of the CIE LAB parameters were calculated.

RESULTS

Means and standard deviations of the three color parameters (L^* , a^* , b^*) and the statistical significance between the parameters of male and female subjects were presented in Table 1. There appears to be a statistically significant difference in the a^* and b^* values of the color parameters between male and female subjects. The results of the color parameters measured from the middle third of 100 natural teeth were illustrated in two dimensional plots (L^*/a^* and L^*/b^*) as shown in Figures 1 and 2.

Table 1. Means and standard deviations of the color parameters of the examined group and the statistical significance.

Color parameters	Means (SD) of female data	Means (SD) of male data	Significance
L^*	83.83 (3.3)	83.75 (4.4)	0.9
a^*	-1.87 (0.6)	-1.05 (0.9)	0.0*
B^*	19.00 (4.3)	22.23 (3.9)	0.0*

*Statistical significance $P < 0.05$

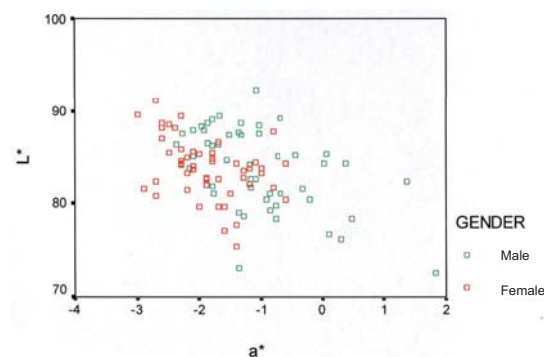


Fig. 1: L^* / a^* chart of female and male teeth, in CIELAB color space.

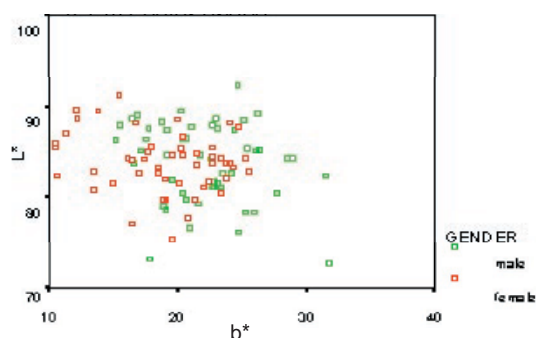


Fig. 2. L^* / b^* chart of female and male teeth in CIELAB color space.

The closest shade match of the examined teeth relative to the Classic Vita Lumin Vacuum shade guide as indicated by the (VES) was shown in Table 2.

Table 2. Frequency and percentage of the closest shade match to the examined subjects' teeth as indicated by the (VES).

Shade	Frequency and percentage of female sample (n = 50)	Frequency and percentage of male sample (n = 50)
A ₁	9 (18%)	10 (20%)
A ₂	2 (4%)	8 (16%)
A _{3.5}	-	1 (2%)
B ₁	7 (14%)	-
B ₂	30 (60%)	24 (48%)
B ₃	-	5 (10%)
C ₁	1 (2%)	1 (2%)
C ₂	1 (2%)	1 (2%)

DISCUSSION

The distribution of natural teeth in the color space indicated the regions of color space that aid the matching of restorations with natural teeth. The middle site of a tooth appears to represent the best tooth color⁷ and the main color of the tooth body.^{1,7} In the present study, the middle third of a maxillary central incisor was measured using the VES, an intra-oral dental spectrophotometer. This instrument provides measurements of the teeth shade in CIELAB units.

The CIELAB system standardizes both light sources and the human visual response (receptor), eliminating these as

variables. It is accepted universally as color specification system. One of the most important features of the CIELAB system over the Munsell system is its arrangement as an approximately uniform three dimensional color space. A uniform color space is one whose elements are equally spaced on the basis of visual color perception. A unit change in each of the three color parameters is approximately equally perceived. Although no numeric system is visually perfect, it does provide an objective means of obtaining information about the location of the object color in the color space and the magnitude and direction of color differences that occur among different object colors.¹⁰

The color of teeth was reported to be affected by age.^{7,11,12} Accordingly, the subjects examined in this study were of the same age range to eliminate the effect of this variable. Statistically significant differences were not found when the L^* values were compared with male and female subjects. The lightness L^* values of the teeth of female subjects were comparable to that of the male. This finding disagreed with other studies where women's teeth were found to be lighter compared to men's teeth.^{4,7} In this study, female's teeth appear to have less yellow and red color compared to the male's teeth, which was in agreement with Goodkind *et al.* They reported that females, on average, have less saturated and less reddish teeth compared to males.⁷

The most frequent shade obtained by the VES in the subjects examined was B2 followed by A1 of the VITA classic Lumin Vacuum shade guide. The recommended VITA shade by the instrument was given according to the minimum difference (ΔE) between the color parameter of the examined tooth and that of the digital color library of the shade guide in the instrument database. The accuracy

of the target shade obtained from the measurement was only as good as the database and its distribution of reference shades.¹³

Further Recommendation

Even though the sample in this study does not represent the overall young Saudi population, it could still be used as a baseline information. Further extensive mapping of the color range of a larger sample from this population is recommended.

CONCLUSIONS

Within the limitations of the design of this study, the following conclusions can be drawn:

1. There was no significant difference in the level of brightness of the maxillary central incisors between males and females.
2. Female teeth appear to have less yellow and red color compared to the male teeth.

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