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Original article

COLOR CHARACTERISTICS OF THE ANTERIOR TEETH IN DENTAL STUDENTS

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ABSTRACT

Introduction: Tooth color is a key determinant of dental aesthetics and critically influences patient satisfaction. Traditional shade matching is subjective and inconsistent, while spectrophotometry offers standardized, reproducible, and objective measurements. Defining the natural color profiles of anterior teeth in young adults is essential for predictable and high-quality esthetic restorations.

The purpose of this study is to analyze the color characteristics of the maxillary central incisors, lateral incisors, and canines in a population of young adults aged 18–21 using a spectrophotometer (Spectroshade; MHT Optic Research).

Materials and Methods: Color measurements were conducted on 153 dental students aged 18–21 years using the SpectroShade Micro spectrophotometer. The teeth examined were maxillary central (11, 21), lateral incisors (12, 22) and canines (13, 23). VITA Classical shades were matched and subsequently converted to CIELAB values (L*, a*, b*). Statistical analysis included mean, SD, and one-way ANOVA ($\alpha = 0.05$).

Results: The central incisors had the highest L* (lightness) values, indicating greater brightness. Canines presented significantly higher b* values, reflecting more pronounced yellowness. Statistically significant differences ($p < 0.05$) were observed among the tooth groups.

Conclusion: Color parameters of anterior teeth vary significantly between tooth types in young adults. These findings are valuable for aesthetic restorative procedures and provide a reference for shade selection in this age group.

Keywords: color, CIELAB, VITA Classical, SpectroShade, dental aesthetics, shade, spectrophotometry,

INTRODUCTION

Tooth color plays a vital role in the perceived esthetics of a smile and is an essential factor in restorative and prosthetic dentistry [1]. The process of matching tooth shade is traditionally done using visual comparison against reference shade guides such as the VITA Classical system. However, this subjective approach is often influenced by lighting, observer perception, experience, fatigue, and surrounding conditions [2]. Recent advancements in digital dentistry have introduced color measurement devices such as spectrophotometers, which allow for more objective and reproducible evaluations of tooth color. SpectroShade is a widely accepted system that provides color parameters based on the CIE L*a*b* color space [3], a standardized color model developed by the International Commission on Illumination (CIE) for precise and objective color determination in dentistry and other fields. This system quantifies color using three coordinates [4]:

- L* (lightness),
- a* (green-red axis),
- b* (blue-yellow axis).

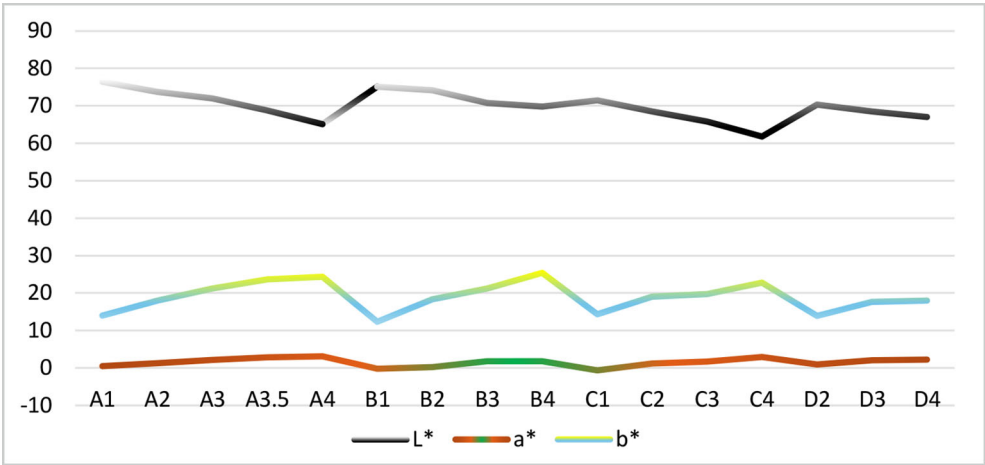
By converting traditional shade values into numeric data, clinicians can achieve greater accuracy and consistency in shade matching (figure 1.) for direct and indirect restorations [5, 6].

Several studies have investigated the natural color range of human teeth in various age groups, ethnic populations, and tooth types [7, 8, 9]. However, limited data exists for young Bulgarian adults, particularly regarding detailed spectrophotometric profiles of maxillary anterior teeth. Understanding these differences can help develop shade selection protocols that improve patient satisfaction and esthetic outcomes.

PURPOSE

The purpose of this study is to analyze the color characteristics of the maxillary central incisors, lateral incisors, and canines in a population of young adults aged 18–21 using a spectrophotometer (Spectroshade; MHT Optic Research).

Fig. 1. CIELAB values by Vita Classical



MATERIALS AND METHODS

Sample Selection

This cross-sectional observational study was conducted on a cohort of 153 healthy dental students enrolled at the Faculty of Dental Medicine, Medical University – Sofia. Participants were between 18 and 21 years old, representing a relatively homogeneous age group regarding dental development and enamel maturation.

Inclusion Criteria

Participants were included based on the following predefined criteria:

• Absence of previous restorative procedures, external bleaching, or traumatic injuries in the anterior dentition

• Maintenance of optimal oral hygiene as assessed by a plaque index Silness and Löe <1

• Clinically healthy enamel without visible discolorations, opacities, or developmental defects

Exclusion criteria

Subjects meeting any of the following conditions were excluded to eliminate potential confounding factors:

• Presence of anterior restorations, including crowns, veneers, or composite fillings

• Active tobacco use, due to its known effect on tooth color and surface characteristics

• History of intrinsic discoloration related to tetracycline exposure or dental fluorosis

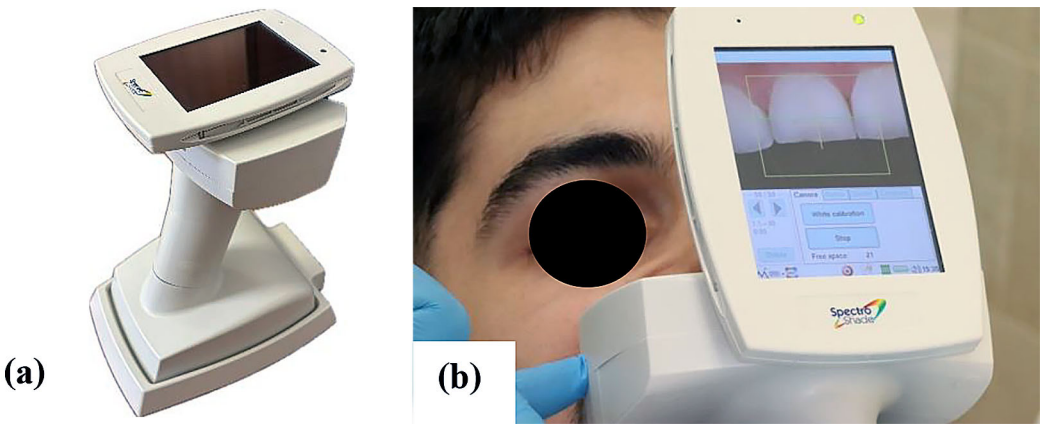
• Diagnosed periodontal disease or gingival inflammation in the anterior region

Measurement Procedure

Tooth color assessment was performed using a calibrated SpectroShade Micro spectrophotometer (MHT Optic Research) (figure 2a), a validated digital imaging system with documented repeatability and reliability in shade determination. The device utilizes a high-resolution intraoral camera and matches tooth shade with the VITA Classical scale while simultaneously providing objective color measurements based on the CIE L*ab** color space.

All measurements were conducted under standardized conditions of natural daylight, with ambient light and patient positioning controlled to minimize variability (figure 2b). Prior to measurement, the buccal surfaces of the maxillary anterior teeth were cleaned using a non-abrasive prophylactic brush and distilled water to eliminate plaque biofilm and extrinsic stains. Each of the following teeth – maxillary central incisors (11, 21), lateral incisors (12, 22) and canines (13, 23) – was measured at the middle third of the labial surface. To ensure reliability, two successive readings were recorded per tooth, and the mean value was used in subsequent analysis. All assessments were performed by a single calibrated examiner to reduce inter-observer bias.

Fig. 2. (a) SpectroShade Micro spectrophotometer (MHT Optic Research) **(b)** Tooth color measurment



Color Data Conversion

The SpectroShade software automatically provides a VITA Classical shade match. Subsequently, each identified shade was converted to its corresponding CIE L*, a*, and b* coordinates using a standardized and previously validated conversion matrix based on manufacturer-provided data and corroborated by peer-reviewed literature [5, 6, 10, 11]. The L* value represents lightness on a scale from 0 (black) to 100 (white), while a* indicates the green–red axis, with negative values toward green and positive toward red, and b* reflects the blue–yellow axis, with negative values toward blue and positive toward yellow. This approach allowed for a more objective and quantitative analysis of tooth color variations across the study sample.

Statistical Analysis

Data were analyzed using SPSS v.28. Descriptive statistics (mean, standard deviation) were calculated for each tooth group. The normality of data distribution was determined using Shapiro-Wilk test, and the homogeneity of the data was confirmed by Levene test. One-way ANOVA and Tukey post-hoc test were used to compare color parameters across the three tooth types. The significance level was set at $\alpha = 0.05$.

RESULTS

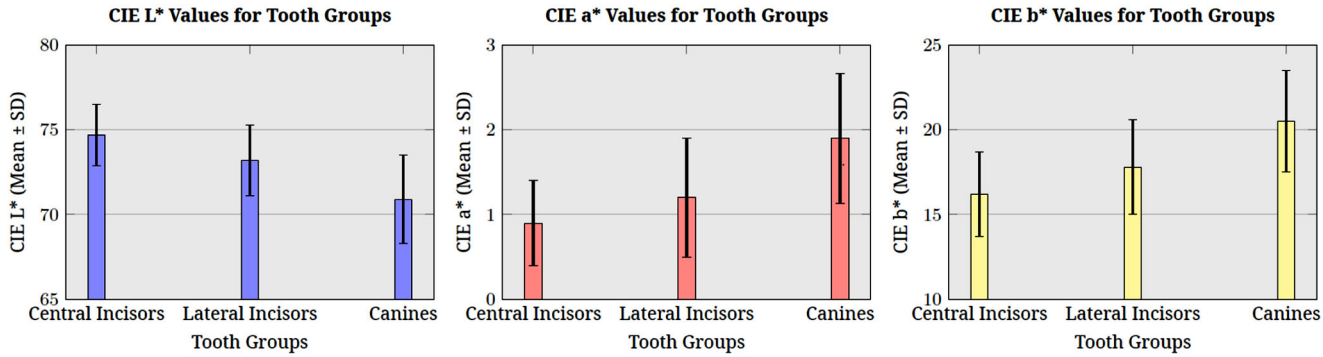
The results revealed distinct patterns among different tooth groups (table 1)(figure 2). The L* values, indicative of lightness, were highest in the central incisors (74.7 ± 1.8), identifying them as the lightest teeth, and lowest in the canines (70.9 ± 2.6). The a* values, corresponding to the red-green axis, demonstrated a slight increase from central incisors to canines, indicating a subtle shift toward red. The b* values, representing the yellow-blue axis, showed a significant increase in canines, reflecting a pronounced shift toward yellow. Statistical analysis using one-way ANOVA revealed statistically significant differences for L* values among all three tooth groups (p=0.001). Similarly, significant differences were observed for both b* values (p=0.001) and a* values (p=0.001). However, post-hoc analysis with the Tukey test showed statistically significant differences between all the individual tooth groups for each parameter.

Table 1. CIELAB color parameters (Mean ± SD) and One-Way ANOVA p-values for maxillary anterior tooth groups.

	Tooth groups			
Color parameters	Central Incisors *Mean ± SD*	Lateral Incisors *Mean ± SD*	Canines *Mean ± SD*	
CIE L*	74.7 ± 1.8	73.2 ± 2.1	70.9 ± 2.6	$p < 0.001$
CIE a*	0.9 ± 0.5	1.2 ± 0.7	1.9 ± 0.77	$p < 0.001$
CIE b*	16.2 ± 2.5	17.8 ± 2.8	20.5 ± 3.0	$p < 0.001$

CIE L indicate lightness, a*- green-red axis, b* - blue-yellow axis*

Fig. 3. CIELAB color parameters L*, a*, b* values for central, lateral, and canine teeth.



DISCUSSION

The results of this study confirm that anterior tooth color varies according to tooth type. Central incisors had the highest brightness (L*), while canines were more chromatic, particularly in the yellow spectrum (higher b*). These findings are consistent with those reported in similar studies across different populations, suggesting a universal anatomical influence on tooth color [12].

The increased yellowness and decreased lightness in canines may be attributed to their greater dentin thickness and lower enamel translucency. Additionally, enamel prisms and light-scattering properties differ between tooth types and contribute to the visual appearance of the color [13].

From a clinical perspective, the results underline the importance of selecting individual shades for different anterior teeth during aesthetic restorations. Using the same shade for all six anterior teeth often results in unnatural outcomes. Digital spectrophotometry, in combination with conversion to CIELAB coordinates, offers a high degree of precision and standardization [14].

Our findings provide a reference database for young adults, which can be used during composite layering, ceramic veneer fabrication, and crown production. Additionally, the use of digital devices improves communication with dental laboratories [11].

Moreover, the age of the participants (18–21 years) is a key factor in interpreting the results. At this age, teeth typically have not undergone significant external changes due to abrasion, erosion, or pigmentation, making them especially suitable as a reference group for baseline color characteristics. However, although the sample is relatively homogeneous, it does not represent the full demographic and ethnic diversity of the Bulgarian population, which limits the generalizability of the results. Future studies should analyze color differences among various ethnic groups, as melanin pigmentation, enamel structure, and genetic characteristics can significantly influence tooth color [15].

Another practical aspect is the need for an individualized aesthetic strategy in restorative procedures. The results confirm the necessity of using different shades when restoring central, lateral, and canine teeth. Ignoring these variations can lead to an unnatural and disharmonious appearance of the smile. The use of digital color measurement devices, in combination with CIELAB coordinates, enables a high level of accuracy and reproducibility, which is especially important in the fabrication of CAD/CAM restorations and customized veneers [16]. It is also noteworthy that in practice, many dentists still primarily rely on visual shade selection using the VITA Classical scale despite its known subjectivity. The integration of objective tools such as spectrophotometers into routine clinical practice requires training, financial investment, and a shift in habits but brings significant benefits in terms of quality and predictability of aesthetic outcomes [17].

In addition, digital measurements can be used to monitor bleaching procedures [18, 19], to track long-term outcomes of restorations and in the educational process for training future dentists in aesthetic diagnostics. The present study could serve as a foundation for developing a localized database of Lab* values for the Bulgarian population, which may be used as a clinical reference in both treatment planning and dental education.

Limitations of this study include the restriction to a single age group and population sample. Future studies should include longitudinal analysis, diverse ethnic groups, and the effect of variables such as gender, diet, and lifestyle.

CONCLUSION

This study demonstrates that there are statistically significant differences in color parameters among maxillary anterior teeth in young adults. Central incisors are the lightest, and canines are the most chromatic. The data presented serve as a practical reference for clinicians and dental technicians when planning esthetic treatments. The use of digital spectrophotometers such as SpectroShade ensures accurate, reproducible results, reducing errors in shade selection and enhancing patient satisfaction. Integration of CIELAB values into clinical practice should be encouraged in both restorative and prosthetic dentistry.

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