

# Color distribution of gingiva created by color schema maker software

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## ABSTRACT

The aim of this study is to create a true gingival shade guide using schema maker softwares.

128 patients' gingival colors were recorded by a standardized photograph machine under standard light and distance conditions. The recorded images were analyzed by Gimp software to extract RGB values by using color pick tool. RGB values were converted to CIE L\*a\*b\* values. L\* values were clustered by ward method. The average CIE L\*a\*b\* values calculated. Gingival images were layered by Gimp software and evaluated by Wenovo pictures to colors software v1.0.

According to this study, 3 clusters using CIE L values and 9 subclusters with using CIE a\*b\* values have calculated by hierarchical and k means clustering methods. 256 colors that can be used for gingiva color determination has been calculated by Wenovo color schema maker software.

With the limits of this study, colors of the gingiva were evaluated for only white race and patients who admitted to our university. Wenovo schema maker software calculated more colors than statistical method that can be used for color determination of the gingiva. Further studies are needed to create more reliable color gingiva shade guide with a large number of patients and different races and places.

**Key Words:** Gingival color, shade guide, Gimp, Wenovo

## Introduction

The basic of the aesthetic rehabilitation is the color selection in prosthetic restoration (1). In prosthetic restorations where the gum to be reconstructed, there is a need for gum color scale to determine the patient's gum color between technicians and the dentist (2). In the literature, there have been made various studies with the aim to identify the healthy gingival color (3). As a result of these studies, various gum color scales are available to the dentists (4,5). However, only healthy patients were evaluated in these color scales (5,6). Gum colors were compared with the skin colors of the individuals in various phenotypes such as blonde, brunette, red-haired, blue-eyed people (7). There has been made a few number of studies which evaluated the gum color of the diseased and healthy individuals in the literature.

The differences in colors is described as  $\Delta E$  (2). In studies, gum colors were measured by color spectrophotometers or specially designed cameras (2,8). Color information were extracted from the resulting images (5,8,9). When the data distribution of these color information's Lab values were examined statistically, with the

average color values obtained by using  $\Delta E$  values equally spaced, these values could be used as a color scale (2,7). In these studies, usually 3-10 different colors has been reported for use in color scales (2, 3).

The effects of factors such as race, gender, age, etc. were examined with gum colors (2,6). However, the detection of these differences in practice will not be able to benefit to dentists. Studies conducted in this manner has brought about the creation of a gum color scale where all kinds of gum colors included with regardless of factors such as gender, age, race, skin color, habits and whether diseased or not.

In these studies, colors are evaluated statistically and resulting 3-dimensional color data are also clustered and the majority was used as the reference point to create the color spectrum of the gingiva (2,3,5). There is no color data for the gingiva that is not commonly seen in these studies (2,6,10). With the lack of this data, dentist and technician could not communicate the same color language and they will use subjective data rather than objective data for color determination. This could cause some problems in aesthetic restorations.

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There is a need to produce a gingival shade guide using standardized cameras with a method of using color detecting softwares and without evaluating or calculating  $\Delta E$  values of the gingiva photographs.

According to these studies, we have proposed to create a wide gingival color scale by using commercially available softwares specially designed to create a color scheme.

**Materials and methods**

128 patients were included in this study from the Faculty of Dentistry, Yuzuncu Yil University, Van, Turkey, after approval by Yuzuncu Yil University Faculty of Medicine Ethical Committee. All patients were informed about the measurements and the aim of the study. Required photographic records were taken after medical history was taken from all patients included in this study. Photographic records were taken with a standardized machine under standard light conditions and fixed distance with the objective and the gingiva.

Lighting is provided by 1 watt 6500k day light SMD LED lamps. 5 LEDs is fixed left side of the objective and 5 LEDs is fixed to the right side of the objective with 45 degree angle for preventing the images from reflectance. Photographic machine is standardized by ISO 100, shutter speed 1/30, 24 bit depth, vertical and horizontal resolution is 480 dpi. All automatic modes were turned off. The repeatability of the measurements were evaluated and %98 repeatability has been approved in this study. The repeatability is determined by using *Vita Dental Shades* (VITA Zahnfabrik H. Rauter GmbH & Co. KG) and evaluating different times by standardized photographic measurements (3,5).

The Gimp (GNU Image Manipulation Program 2.8) software is used to extract RGB values from gingiva photographs. Color pick tool is used to determine the color values. The color pick tool radius level set to 50. The color data taken from the information screen of the color pick tool is transferred to L\* a\* b\* values. The L values is clustered using ward technique. L values is shown in figure 1. As color pick tool radius is set to 50, standard measurements have been evaluated from the tooth gingiva by using Gimp (GNU Image Manipulation Program 2.8) software.

These pictures then added to layers separately by using Gimp (GNU Image Manipulation Program 2.8) software as seen in figure 3. These layers aligned and superimposed to create a color database which will be used by the color scheme maker software (Pictures to colors Version 1.0 WENOWO Software 2016 designed by *Wenovo*). With this method, the color data from all patients evaluated without using any statistical software.

Rare seen color data is a lack of the color studies published in literature. And the person who has this rare gingiva colors has disadvantages for acceptable restorations. According to this study, we can identify all colors from gingiva by using *Wenovo* color schema maker software (Pictures to colors Version 1.0 WENOWO Software 2016). Calculated results with *Wenovo* software is shown in figure 4.

128 patients gingiva colors CIE L\*a\*b\* values were calculated at 4 different points and mean CIE L\*a\*b\* values were calculated and described as patients gingival colors. These data than clustered by ward hierarchical clustering method using R version 3.2.5 statistical software (© The R Foundation 2016). The distribution of L values are shown in figure 1. Calculated dendograms of L values are shown in figure 5. Then the individuals

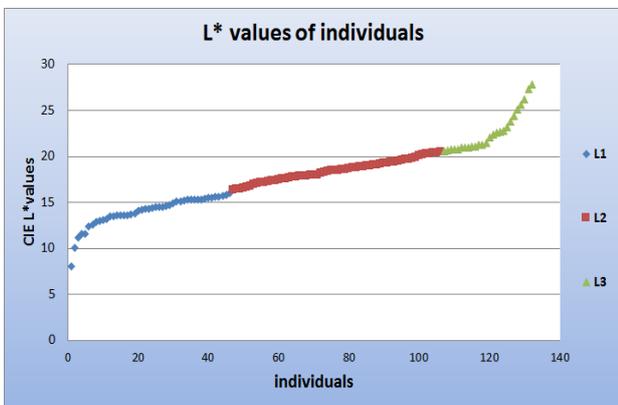


Fig. 1. Distribution of CIE L\* values of individuals.

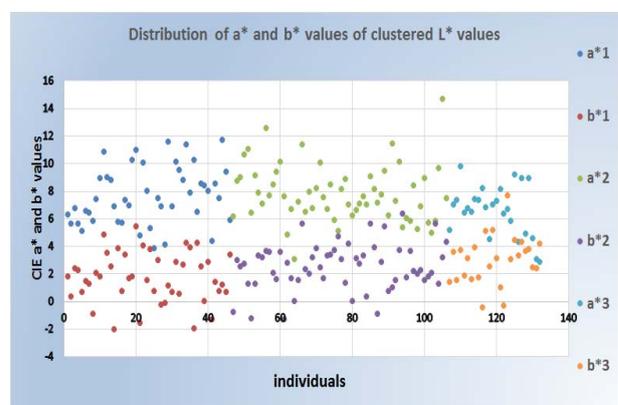


Fig. 2. Distribution of CIE a\* b\* values of individuals.



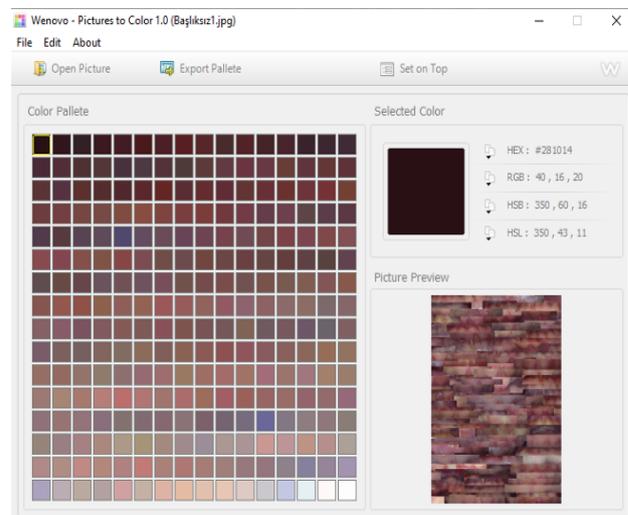
**Fig. 3.** Gingiva images layered with Gimp software.

were separated to 3 groups according to CIE L\* values. The CIE a\* and b\* values were used to subclustering the individuals gingival color data by using ward hierarchical clustering method and k means method. The distribution of a\* b\* values are shown in figure 2. The subclustered a\* b\* dendograms of gingiva are shown in figure 6, figure 8 and figure 10. Cluster plots of the groups are shown in figure 7, figure 9 and figure 11. The calculated clusters are shown in table 1.

## Discussion

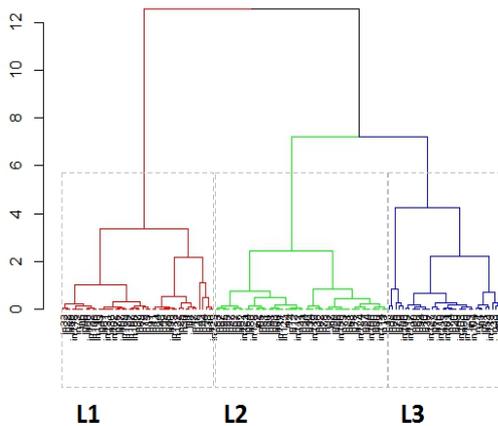
Selection of tooth color is known to be important aesthetically (1). In prosthetic rehabilitation cases where the gingiva has to be restored, gingival color match is as important as aesthetic tooth color harmony (2).

Although the tooth color perfectly matched, in cases where the gingiva need to be restored, aesthetic incompatibilities that might occur would not satisfy patients (2). It has been shown that the gingival color shades did not represent the patients' gingival color distribution and described this difference as coverage error (4,5).



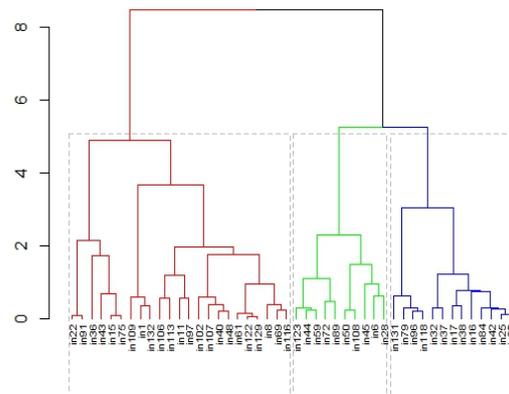
**Fig. 4.** Wenovo calculated palette.

**Cluster dendrogram of CIE L\* values**

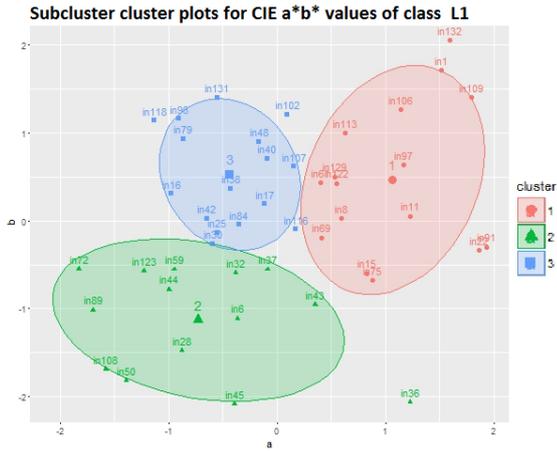


**Fig. 5.** Cluster dendrogram for CIE L values of individuals calculated by R version 3.2.5 statistical software. (© The R Foundation 2016)

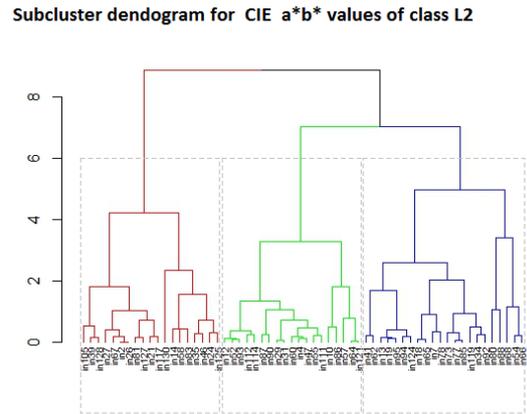
**Subcluster dendrogram for CIE a\*b\* values of class L1**



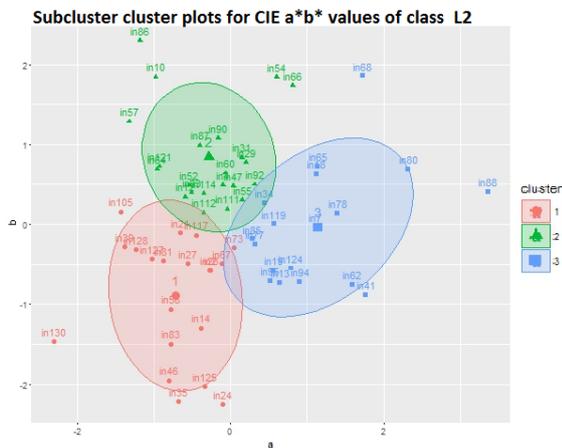
**Fig. 6.** Subcluster dendrogram for CIE a\*b\* values of class L1 individuals calculated by R version 3.2.5 statistical software. (© The R Foundation 2016)



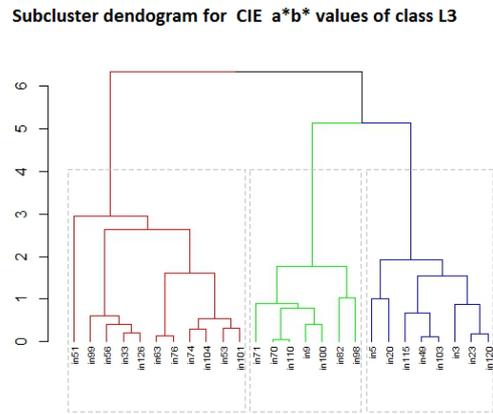
**Fig. 7.** Subcluster cluster plot results for CIE a\*b\* values of class I L individuals calculated by R version 3.2.5 statistical software. (© The R Foundation 2016)



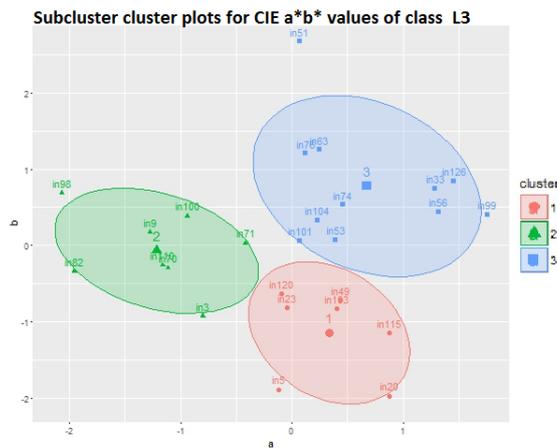
**Fig. 8.** Subcluster dendrogram for CIE a\*b\* values of class II L individuals calculated by R version 3.2.5 statistical software. (© The R Foundation 2016)



**Fig. 9.** Subcluster cluster plot results for CIE a\*b\* values of class II L individuals calculated by R version 3.2.5 statistical software. (© The R Foundation 2016)



**Fig. 10.** Subcluster dendrogram for CIE a\*b\* values of class III L individuals calculated by R version 3.2.5 statistical software. (© The R Foundation 2016)



**Fig. 11.** Subcluster cluster plot results for CIE a\*b\* values of class III L individuals calculated by R version 3.2.5 statistical software. (© The R Foundation 2016)

**Table 1.** The clusters calculated by ward hierarchical clustering method and k means method calculated by R version 3.2.5 statistical software (© The R Foundation 2016)

Cluster	I			II			III		
L	14.003			18.416			22.634		
a	9.922	6.181	6.793	6.358	7.254	10.177	7.219	4.424	7.833
b	2.599	-0.277	2.711	1.044	3.951	2.474	1.027	2.909	4.384
n	16	14	16	20	22	18	7	8	11
N	46			60			26		

n: number of individuals in subclusters, N: number of individuals in clusters.

Numerous methods have been developed to determine the color of the tooth (11). However, the same technological development does not involve the gums (7). Color definitions could be made by visual, photometric or spectrometric methods (12). Most of the studies about color definition is made by visual method and these studies evaluated the subjective color data (12). This visual method could be affected by lightning conditions, to the dentist's or technician's experience, age, eye fatigue, etc. (13). In a recent study, it has been shown that the lightning conditions could change the color matching. They described this situation because of the metamerism (14). This method can be used easily and more economic than other methods. For this reasons there are lots of studies made by visual method (7,15). With the development of technology, photometric color measurement has become more reliable (8).

It has been described that the most important value for visual shade matching is CIE L\* values (13,16). The CIE L\* values were clustered by ward method, the clustered groups then reclustered by ward method using CIE a\* values descending (2). When statistical analysis used like cluster analysis or multivariate analysis, some of the data will not refer a color value. Huang and coworkers describe their results as the most common color values in their study. But some color data was not evaluated or described in the results (2). These undescribed colors could be used by dentists to communicate the color values with the technicians.

There are some color scheme maker softwares like Adobe Color CC Software (Adobe systems incorporated 2015), COPASO: Color Palette Software (online service of Creative Market Labs, Inc.2016), and WENOVO (Pictures to colors Version 1.0 Wenovo Software 2016). These programs has some algorithms that can evaluate all existing colors in a photograph. As we

described before, some studies demonstrate that the gingival colors scales does not cover gingival colors completely. The lack of some studies like calculating only attached gingival color, not the alveolar or papillary mucosa color, could not cover whole gingiva colors (5).

The color harmony in prosthetic restorations that has pink color is crucial and it must match with the papillary mucosa or alveolar mucosa, too (2).

There is IPS gingiva and Lucitone 199 shade guides that could evaluate the pink color of the gingiva. Ivoclar plus has 4 color shade guide and this 4 color is a small number for gingiva color distribution. It has been described that the color range in gingiva must be wider than the color range in teeth (5).

Human eye can detect color differences more than 1 Δ E values differences (17). More than 2.75 Δ E value difference was described as unacceptable color difference clinically (5). In a recent study, the color differences were evaluated with the patient's gingival colors and the clinically available shade guide colors. The Δ E values were calculated different as 7.9 to 10.8. These results were higher than 2.75 Δ E value difference and described as unacceptable color difference (5).

## Results

Our findings demonstrates that reasonable color CIE L\*a\*b values could be calculated with the statistical softwares that could be used in gingival shade guides. According to our findings, 3 clusters calculated by using CIE L values using hierarchical ward clustering method and 9 subclusters with using CIE a\*b\* values which were evaluated by hierarchical and k means clustering methods (Table 1). But according to a recent study, the shade guides calculated with statistical methods could have some disabilities to represent the true gingival color data to technician (5). Dentists have

to calculate all of the colors that could be seen in gingiva. This could only be made possible with professionally designed softwares that could create color scheme of a selected picture. These softwares have algorithms that do not miss any color data which could be used by a painter.

According to these findings, commercially available gingiva shade guides have missing colors and they have disabilities to be used in clinics. Besides the statistically calculated colors, it must be calculated wider color values with scheme maker softwares that have different algorithms. The Wenovo color schema maker software results showed that there are more colors in gingiva than calculated statistically in this study. The calculated color values are shown in figure 4. Wenovo software has calculated 256 different colors comparing to statistical results.

According to our study, calculated results by Wenovo software have more gingiva colors that could cover the whole gingiva colors.

Limited results have been obtained, since only the white race and only the patients who admitted to our clinic were evaluated in this study. Further studies must be made by researchers with a high number of patients and not only with one race and one country.

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