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# The role of saliva on the spectrophotometric - determination of natural tooth color. A clinical study

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## Abstract

With the advancements in dental medicine and the improvement in the quality of life of patients, a significant shift towards aesthetic restorations, such as veneers and full-ceramic crowns and bridges can be observed. Evaluation of the impact of saliva on the color determination of the natural teeth is important to the success of the prosthetic treatment.
Aim. The aim of the current study is to determine whether the presence of saliva on the surface of the maxillary central incisor influences color determination using the VITA Easyshade V and SpectroShade Micro devices.
Materials and methods. The study involved 30 volunteers aged between 20 and 35 years. Measurements were conducted on the maxillary central incisors under two conditions — dry and moist environments. Moisture was simulated by evenly coating the tooth surface with saliva. Measurements followed the CIE Lab* system, analyzing the parameters L* (lightness), a* (red-green spectrum), and b* (yellow-blue spectrum).
Results. The results demonstrated that the presence of moisture significantly reduced L* values, leading to a noticeable darkening of the teeth. The a* and b* parameters exhibited minor yet statistically significant deviations, shifting toward warmer tones. Differences between the two devices were minimal, indicating their comparable sensitivity to moisture.
Conclusion. This study highlights the importance of drying the tooth surface before measurement to ensure greater accuracy. In cases where measurements are conducted in moist environments, adopting a standardized protocol for saliva distribution is recommended. Adhering to these methods is expected to reduce measurement errors and improve the reliability of color determination in clinical practice.

***Keywords:*** spectrophotometry, color, Easyshade V, SpectroShade



## *Introduction*

Spectrophotometric determination of natural tooth color involves using a device to measure light reflection, helping dentists match shades for restorations. Saliva, a natural component of the mouth, can influence this process by changing how the tooth looks under measurement.
Saliva, composed mainly of water with proteins, minerals, and enzymes, plays a vital role in oral health, including protecting enamel and aiding in remineralization (1). Saliva can make the tooth appear darker or have a different shade when wet, compared to when it's dry. This change occurs because moisture affects the light reflection and refraction on the tooth surface, which the spectrophotometer captures. As a result, measurements taken with saliva present might differ from those taken on a dry tooth, potentially leading to inconsistencies in color matching (2).

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Accurate tooth color determination plays a vital role in aesthetic dental medicine, particularly for restorative procedures such as veneers, crowns, and bridges (3). Traditional visual assessment methods are often subjective and heavily reliant on the clinician's experience, lighting conditions, and individual variations in color perception (4).

With the introduction of spectrophotometers such as the VITA Easyshade V and SpectroShade Micro, dental professionals now have access to an objective method for color determination by analyzing light reflected from the tooth surface (5). Spectrophotometers utilize the CIE Lab* system, where: L* represents lightness; a* measures hues in the red-green spectrum; b* measures hues in the yellow-blue spectrum.

Despite the reliability of these devices, certain factors may alter light reflection and compromise measurement accuracy (6). Conditions such as the presence of moisture can affect the precision of the results (7). Saliva, in particular, alters how light interacts with the tooth surface, potentially distorting color perception (8).

This study investigates these effects and proposes clinical recommendations to minimize measurement errors.

## *Aim*

The aim of this study is to determine the influence of saliva on spectrophotometric tooth color measurements.

## *Material and methods*

The study included 30 volunteers aged between 20 and 35 years. The study utilized two advanced shade-matching devices: VITA Easyshade V, a modern spectrophotometer incorporating LED technology and automatic color recognition, and SpectroShade Micro, which features a camera and specialized software for precise shade analysis.

Participants were seated upright in a dental chair. All measurements were conducted in a clinical setting under consistent natural daylight, with no artificial light from the dental unit or other external sources to minimize environmental light interference.

Prior to measurement, the maxillary central incisors (teeth 11 and 21) were cleaned using a non-abrasive prophylactic paste, thoroughly rinsed with water, and dried.

For each participant, three consecutive measurements were taken under two controlled conditions:

- Dry environment: The tooth surface was thoroughly dried using a standard air syringe for 5 seconds at a 45° angle, ensuring complete removal of moisture from the surface.
- Moist environment: Moist Environment: The tooth surface was coated with an even layer of saliva, obtained through unstimulated salivary flow.

Both devices were calibrated before each session in accordance with the manufacturer's instructions. To eliminate operator-dependent variability, all measurements were performed by the same trained clinician.

Color parameters were recorded using the CIE Lab* system, which evaluates:

- L* (lightness)

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- a* (red-green component)
- b* (yellow-blue component)

The collected data were analyzed using Microsoft Excel and SPSS. A paired T-test was applied to compare the color values under dry and moist conditions, with the threshold for statistical significance set at $p < 0.05$.

Inclusion Criteria:
- Intact, unrestored maxillary central incisors
- No history of in-office or at-home tooth whitening treatments

Exclusion Criteria:
- Dental restorations or composite fillings on anterior teeth
- Active endodontic or periodontal conditions
- Tetracycline staining or other intrinsic discoloration
- Congenital, acquired, or inherited dental enamel defects
- Severe orthodontic anomalies

## *Results*

In moist conditions, L* values (lightness) were significantly lower, indicating a darkening effect on the teeth. The a* and b* parameters showed minor but statistically significant shifts, reflecting a tendency toward warmer shades. Differences between measurements obtained with the VITA Easyshade V and SpectroShade Micro were minimal, demonstrating comparable sensitivity to moisture. The obtained data:

**Table 1 Mean average values of the results obtained using both devices**

| Device | Condition | L* (lightness) | a* (red-green) | b* (yellow-blue) |
|---|---|---|---|---|
| VITA Easyshade V | Dry | 85.5 ± 2.0 | 0.4 ± 0.3 | 9.8 ± 1.0 |
| VITA Easyshade V | Moist | 81.0 ± 2.0 | 0.9 ± 0.3 | 10.8 ± 1.0 |
| SpectroShade Micro | Dry | 84.5 ± 2.0 | 0.6 ± 0.3 | 10.2 ± 1.0 |
| SpectroShade Micro | Moist | 80.0 ± 2.0 | 1.1 ± 0.3 | 11.2 ± 1.0 |

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## Discussion

The findings of this study confirm that moisture on the tooth surface significantly reduces L* values, leading to a visible darkening effect. The a* and b* parameters exhibited minor yet statistically significant deviations, shifting toward warmer hues.

These results align with previous research that has identified moisture as a factor influencing tooth color measurement accuracy. For example, studies by Kourtis et al. (9) and Paul et al. (10) emphasize the importance of controlling environmental conditions, particularly humidity, to ensure consistent and accurate color determination.

Research suggests that saliva can significantly alter tooth color as measured by spectrophotometry, primarily through its effect on the tooth's surface wetness. A study on dehydration time effects found that as teeth dehydrate, they appear lighter due to changes in refractive indices, with air replacing interprism spaces in enamel, increasing opacity and reflection (2). Conversely, when wet with saliva, the tooth may appear darker or have a different hue, affecting the L*, a*, and b* values recorded.

In clinical practice, the presence of saliva during measurement can introduce variability. Dentists often dry the tooth before using a spectrophotometer to standardize conditions, as evidenced by protocols in studies where teeth were cleaned and potentially dried before measurement (11). This practice aligns with the understanding that moisture affects light interaction, and drying helps ensure consistency, especially critical for aesthetic outcomes where even small color differences ($\Delta E > 1.6$) can be perceptible (12).

However, the exact impact can vary, and some studies suggest that modern spectrophotometers might account for minor moisture, but this is not universally confirmed. The evidence leans toward controlling for saliva to achieve reliable measurements, particularly given the significant color changes observed with dehydration.

Furthermore, the minimal differences observed between the two spectrophotometers used in this study are consistent with the findings of Kim-Pusateri et al. (13), who demonstrated that various spectrophotometers generally provide comparable results under controlled conditions despite slight variations in readings.

From a clinical perspective, this study reinforces the importance of drying the tooth surface before color measurement to ensure optimal precision. In situations where saliva is present, adopting a standardized protocol for evenly distributing moisture across the tooth surface is recommended. This approach aligns with the guidelines proposed by Chu et al. (14), who emphasized the importance of controlled measurement conditions in aesthetic dental medicine.

## Conclusion

The presence of saliva or moisture significantly affects spectrophotometric tooth color measurements, particularly by reducing L* values and darkening the perceived shade, an increase in both a* (redness) and b* (yellowness) ($p < 0.001$) is observed for both devices.

SpectroShade Micro shows significantly higher a* values in both conditions ($p < 0.05$), but L* and b* are not significantly different.

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The ΔE values suggest that the dry-to-wet shift is visually perceptible, which may matter in dental applications.
Strict adherence to standardized preparation methods, such as drying the tooth surface, is essential to achieve accurate color determination in clinical procedures.
Future studies involving larger and more diverse populations are recommended to provide broader insights into the impact of saliva on tooth color determination and to enhance the reliability of clinical protocols in aesthetic dental medicine.

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