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Original Research

Effect of Two Food Colorants on Three Different Complete Denture Teeth Set at Different Time Intervals

T R Ramesh[1], V Mavani Soham[2], K Kesava Reddy[3], Patel Kavan[4], M Patel Brijesh[2], B Soundharya Aishwarya[2]

Contributors:

[1]Head and Professor, Department of Prosthodontics, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India; [2]Post-graduate Student, Department of Prosthodontics, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India; [3]Reader, Department of Prosthodontics, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India; [4]Senior Lecturer, Department of Prosthodontics, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India.

Correspondence:

Dr. Ramesh TR. Department of Prosthodontics, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India. Email: bhatrameshtr@hotmail.com

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Abstract:

Background: Most of the presently fabricated complete dentures make use of acrylic teeth. In comparison to porcelain teeth due to water sorption properties of the resin, acrylic teeth tend to change their shade over a period of time. Hence, it becomes necessary to study such color changing the pattern and remedial measures to overcome the problem.

Materials and Methods: 6 maxillary anterior teeth were used from 3 different brands of complete denture teeth set. These were divided into 6 groups. Teeth were placed in plastic containers, and no teeth should contact each other. Color stability was measured with a spectrophotometer at 1, 2, and 4 weeks of the interval. Collected data were analyzed with one-way-ANOVA test and *post-hoc* Tukey test.

Results: Acryrock showed a more chromatic change in sunset yellow solution (ΔE = 2.70) than fast green solution (ΔE = 2.05). Ivoclar showed a more chromatic change in fast green solution (ΔE = 2.93) than sunset yellow solution (ΔE = 2.06). Premadent showed a more chromatic change in sunset yellow solution (ΔE = 2.28) than fast green solution (ΔE = 1.94). After 4 weeks of interval, statistically significant difference found in the groups at various intervals of 1 week ($P = 0.000$), 2 weeks ($P = 0.000$), and 4 weeks ($P = 0.038$).

Conclusion: Sunset yellow solution produces more chromatic change than fast green solution. Acryrock is more color stable in fast green solution than sunset yellow solution. Ivoclar is more color stable in sunset yellow solution than fast green solution. Premadent is moderately color stable in both the solution. All groups of teeth have acceptable color stability in the food color solution at the end of 4 weeks of the interval.

Key Words: Color stability, complete denture, denture acrylic teeth set, food colorant, spectrophotometer

Introduction

By far edentulism is most commonly treated by means of complete denture prosthesis. Complete dentures are mainly preferred to restore the masticatory function, esthetic, and phonetics. Complete denture is fabricated of acrylic denture base and acrylic denture teeth.[1]

Historically porcelain teeth were used to fabricate such complete dentures; they had the high esthetic appearance, but there were some disadvantages such as bonding mechanism, brittleness, and clicking sound. To overcome these limitations acrylic teeth were introduced which also have some limitations such as less color stability and wearing of the teeth.

In the present era, usage of preservatives and food coloring agents has become very common in most of food and beverages. Life-style changes have resulted in excessive consumption of such food materials available of the shelf in comparison to freshly prepared teeth. There are some intrinsic and extrinsic factor that causes discoloration like characteristics of the material composition, impurities incorporated during manufacturing or manipulation are intrinsic factors[2,3] and from extrinsic factors, wear and exposure to staining substances causing absorption and adsorption of stains. Surface roughness and chemicals in beverages can lead to wear and surface degradation of artificial acrylic teeth, resulting in staining.[3] In turn, such consumption may lead to a change in color stability of the acrylic teeth.

Hence, it becomes necessary to choose presently available teeth carefully to avoid such complications such as color stability. Thus, we have considered 3 commonly used teeth set considered for this study to evaluate changes in color stability using routinely used food colorants fast green and sunset yellow solution with a different time interval.

Materials and Methods

Preparing the solutions

The fast green solution and sunset yellow solution were prepared by dissolving 3 g of dye into 100 ml of distilled water (3% V/W).

Plastic containers were taken, and base of the each container labeled with water proof pen to represent each brand of teeth. Fast green solution and sunset yellow solution were poured in different container and teeth were placed. Teeth were selected

randomly from each brand and 18 Teeth were placed in one container in such a manner that no teeth should contact each other (Figure 1).

Solution was freshened once in every 3 days. To reduce the precipitation of particles in solutions, solutions were stirred once in a day.

Immersion in solution

A total of 108 samples of cross-linked acrylic denture teeth with 3 different brands (Acryrock, Ivoclar, and Premadent) in which 36 samples of Maxillary anterior teeth of each brand were obtained. Teeth were randomly divided into 6 groups, 18 teeth in each group.

Group A: 18 acryrock denture acrylic teeth in fast green solution

Group B: 18 ivoclar denture acrylic teeth in fast green solution

Group C: 18 premadent denture acrylic teeth in fast green solution

Group D: 18 acryrock denture acrylic teeth in sunset yellow solution

Group E: 18 ivoclar denture acrylic teeth in sunset yellow solution

Group F: 18 premadent denture acrylic teeth in sunset yellow solution

Evaluation of color measurements

All the specimens were mounted in the center of a silicone putty with a plastic mold (Figure 2). This silicone mold was prepared so that repetitive measurements for each tooth could be taken from the same tooth region. All specimens were placed at the center of the measuring head of a spectrophotometer (Figure 3).[4,5] With the aid of a silicone putty jig. Furthermore, this mold enables all teeth from the same brand to sit on the measuring head of the spectrophotometer in the same position. During the processing of the mold, teeth were placed so that their labial surfaces were at the same level as that of the silicone putty material.

Before immersing each set of denture teeth into the solutions, they were stored in distilled water at room temperature for 24 h. After 24 h of immersion, the color measurement of each tooth was performed using the spectrophotometer. After the first measurement, teeth were placed in containers. Subsequent color measurements were taken after 1, 2, and 4 weeks of immersion in solutions.

Teeth were removed from the solutions before each measurement and rinsed in distilled water. Excess water on the surface was removed with tissue papers, and teeth were allowed to dry.[5-7]

Color measurements were made on the labial surface of the teeth using an ultraviolet-visible recording spectrophotometer. The average of the 3 readings was recorded, and the mean

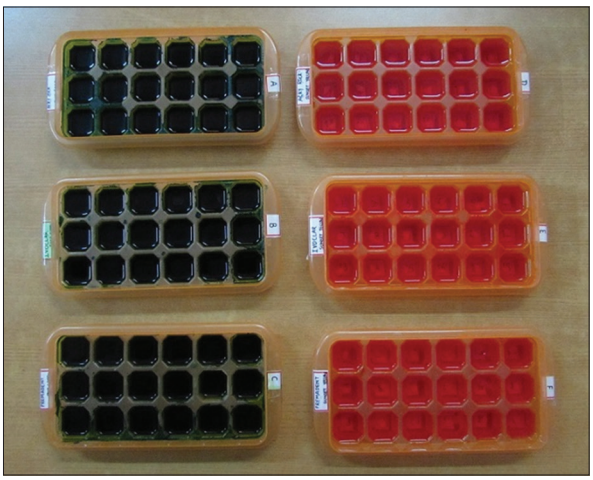


Figure 1: Samples immersed into the solution

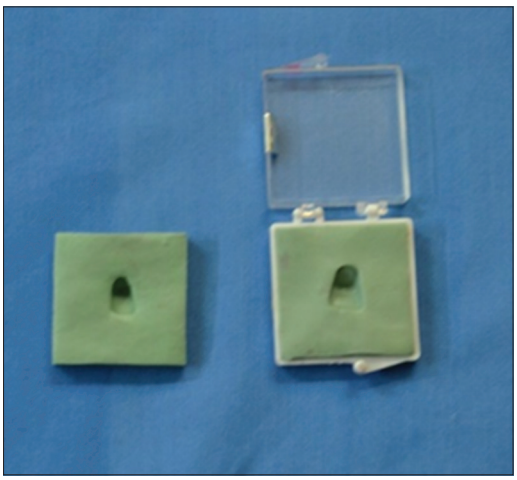


Figure 2: Plastic mold with silicone putty jig

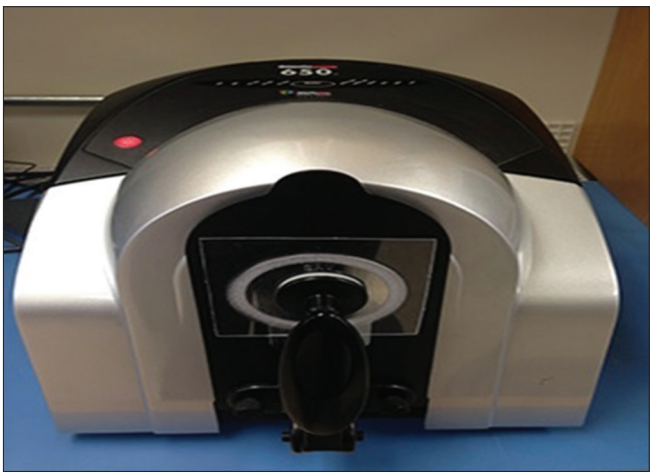


Figure 3: Spectrophotometer

of each material calculated with the use of the Commission Internationale d'Eclairage (CIE) lab uniform color scale.[3,5,8]

Total color difference is formulated by a single number ΔE:

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]\ 1/2$$

Where L* for lightness, a* for redness-greenness, and b* for yellowness-blueness. This formula was designed to provide numeric data that represents the degree of the color difference perceived in between 2 objects.

To determine the average color change after 1, 2, and 4 weeks, the mean and standard deviation of the 18 samples for each solution were calculated. The effects of the solution on the acrylic resin due to time were compared.

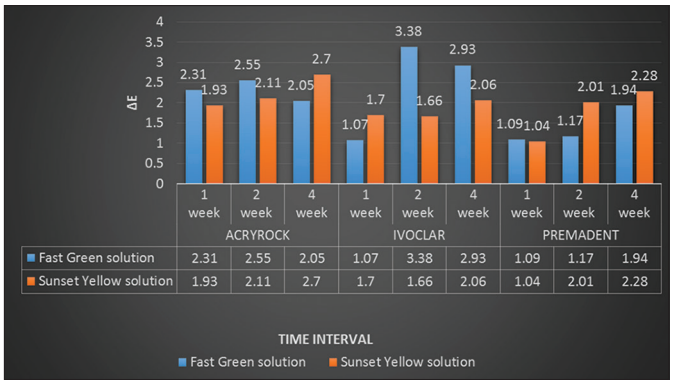
The data were converted to National Bureau of Standards units (NBS units) to correlate the amount of color change through the equation, NBS units = ΔE*×0.92, where critical remarks of color differences as expressed in terms of NBS units (Table 1).[9]

Collected data were statistically analyzed with one-way ANOVA test and *post-hoc* Tukey test.

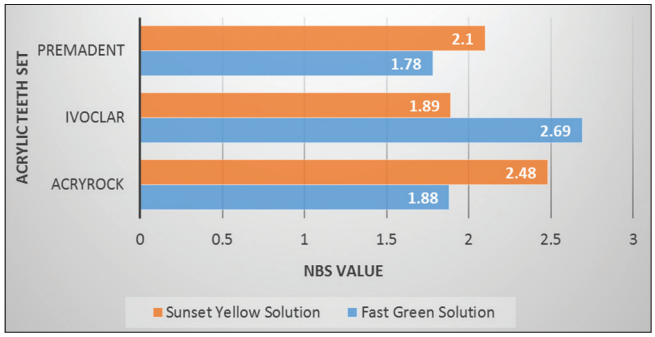
Table 1: NBS ratings.

NBC unit	Critical remarks of color differences	
0.0-0.5	Trace	Extremely slight change
0.5-1.5	Slight	Slight change
1.5-3.0	Noticeable	Perceivable change
3.0-6.0	Appreciable	Marked change
6.0-12.0	Much	Extremely marked change
12.0 or more	Very much	Change to other color

NBS: National Bureau of standards



Graph 1: Mean values (ΔE) of all groups after 1, 2, and 4 weeks of the interval.



Graph 2: National Bureau of Standards values of all teeth set in both solutions.

Results

Graph 1 showed ΔE values of all groups after 1, 2, and 4 weeks of interval and it showed that color change occurs in all groups after immersion in solution. Ivoclar in fast green solution showed higher value at 1 week ΔE = 1.07, 2 week ΔE = 3.38, and 4 weeks ΔE = 2.93 and for sunset yellow solution, acryrock had higher value than other two groups, at 1 week ΔE = 1.93, at 2 weeks ΔE = 2.11, and at 4 weeks ΔE = 2.70. one-way ANOVA test showed a comparison of color change (ΔE) in the study groups at various intervals at 1, 2, and 4 week of the time period. It showed there was statistically significant difference present between all groups at various intervals of 1 week ($P = 0.000$), 2 weeks ($P = 0.000$), and 4 weeks ($P = 0.038$).

The *post-hoc* Tukey test showed at 1 week and 2 weeks of interval there was statistical significance found in some groups but at the end of 4 weeks, there was no statistical significance found between the groups.

Graph 2 showed NBS values of samples after 4 weeks of intervals. Acryrock in sunset yellow solution showed higher chromatic change (2.48) and ivoclar in fast green solution showed higher chromatic change (2.69).

Discussion

In this present study, 3 brands of acrylic denture teeth were used which were the most commonly used brands. All 3 brands had the same chemical structure with a different type of cross-linking agents and plasticizers which may explain the different staining properties of acrylic teeth.

In this study, 2 most commonly available food colors used, which are fast green and sunset yellow dyes. These dyes are water soluble azo dyes, and they are stable with heat alkali and acids. The polymethyl methacrylate denture acrylic teeth are hydrophilic in comparison to porcelain that attracted more water soluble dyes on the surface and staining, which occurs as a result of electrostatic charges.

CIE lab system was used in this study to determine the color stability of the acrylic teeth which is more accurate than Munsell color system.

Graph 1 showed as the time period increases there is an increase in color change. The difference in ΔE values may be due to pH of the solution. The fast green solution had alkaline pH when compared to sunset yellow solution which had acidic pH. This decrease in pH of solution leads to increase in water sorption of the acrylic denture teeth and lead to penetration of the colorants constituents of the solution. One-way ANOVA test showed a comparison of color change ΔE in the study groups at various intervals at 1, 2, and 4 week time period showed there was statistically significant difference present between all groups at various intervals of 1 week (p=0.000), 2 weeks

(P = 0.000), and 4 weeks (P = 0.038). It showed that there was change occurs in acrylic teeth after immersion in the food color solution.

The *post-hoc* Tukey test used to evaluate inter group correlation and it showed that at the end of 4 weeks, there was no significant difference found between the groups. It was due to the absorbent property of acrylic teeth was reduced as the time elapses.

Graph 2 showed color change values after 4 weeks according to the National Bureau of Standards Unit system. The NBS parameter is important for color comparison. When the results were evaluated according to the NBS units of color difference, Johnson and Kao observed that if ΔE was <1, this chromatic value is deemed to be slight and between 1 and 2, the situation is clinically acceptable.[6] Goldstein and Schmitt reported that when ΔE was more than 3.7, it was no longer within the limits of clinical acceptability, and it assumes the quality of visual detectability.[7] In this study, Graph 2 showed that for sunset yellow solution acryrock had higher ΔE value (2.48) and for fast green solution ivoclar had higher ΔE value (2.69). Noticeable change seen for acryrock (1.88) and premadent (1.78) in fast green solution and ivoclar (1.89) and premadent (2.10) for sunset yellow solution. All the groups had values <3 so that it indicates that all the samples had acceptable color stability.

This study showed with advancing time all samples showed increase in staining ability. However, sunset yellow showed more stain than the fast green solution. In fast green solution, premadent was more color stable and ivoclar was less color stable. In sunset yellow solution, ivoclar was more color stable and acryrock was less color stable. At the end of 4 weeks, color stability of acrylic teeth were clinically acceptable.

Conclusion

Within the limitation of this study it can be concluded that:

1. Comparing the color absorption of the solution showed sunset yellow solution causes more color change than fast green solution.
2. Comparing the teeth set after immersion at different intervals of 1, 2, and 4 weeks showed ivoclar was more color stable in sunset yellow solution than fast green solution. Acryrock was more color stable in fast green than sunset yellow solution. Premadent was moderately color stable in both fast green and sunset yellow solution.
3. Ivoclar produced more color change in fast green solution than other 2 groups. Premadent produced least color change in fast green solution than other two groups.
4. Acryrock produced a most color change in sunset yellow solution than other two groups. Ivoclar produced least color change in sunset yellow solution than other two groups.
5. There was statistically significant difference found at the end of the 4 weeks within all the groups.
6. All groups had acceptable color stability in food color solution at the end of 4 weeks of the interval.

Due to the several limitations of this study, further studies should be conducted under standardized condition and protocols.

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