



EVALUATION OF COLOR STABILITY OF FLEXIBLE DENTURE BASE MATERIAL AFTER IMMERSION IN GARAM MASALA USING REFLECTANCE SPECTROPHOTOMETER – AN IN VITRO STUDY

Prosthodontics

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ABSTRACT

The present study was carried out with an aim of evaluation of color stability of flexible denture base material after exposure of GARAM MASALA for particular duration using reflectance spectrophotometer. Thirty flexible denture base material samples (15×15×2mm) were fabricated in this study. Thirty samples were evaluated at 0 day (baseline) before immersion and at 15 days and 30 days after immersion in garam masala solution. Color changes (ΔE) were calculated by reflectance spectrophotometer with the use of C.I.E. L*a*b* uniform color scale. To evaluate the effect one way ANOVA test was carried out, as the results were statistically significant ($p = 0.05$) Multiple comparison test (Tukey's Analysis) was done subsequently. Flexible denture base material undergoes a major color change when immersed in coloring agent (Garam masala). So its use is restricted where conventional denture base resins are not preferable.

KEYWORDS

flexible denture base material, Garam masala, color stability

INTRODUCTION

Polymethyl methacrylate has remained the most popular material for fabrication of complete dentures and removable partial dentures.^{1,2,3} It has several advantages such as low water sorption and solubility, good esthetics, adequate strength, low toxicity, easy to repair and rebase and simple moulding processing technique. However, It has some disadvantages also such as polymerization shrinkage, weak flexure strength, low impact strength and low fatigue resistance and allergic reactions of residual monomer.^{4,5} To overcome these disadvantages, many denture base materials had been introduced out of which flexible denture base materials are getting popular nowadays.

The success of prosthesis and restoration is based on functional and esthetic results.^{6,7,8} To achieve better esthetics four basic determinants are required that is position, contour, texture and color. Understanding of scientific principles of color is important because esthetic dentistry puts demand on artistic ability of both dentist and technician. Better color understanding not only improves esthetics but also makes the restoration attractive and natural.⁷

Color stability and stain resistance criteria are most important clinical properties for dental material.^{9,10} Color stability is a condition in which any dental material maintain its original color regardless of environmental effect. Discoloration of prosthesis may be caused by intrinsic and extrinsic factors. Intrinsic factors are related to physical and chemical conditions such as thermal and humidity changes that occur during aging process. Extrinsic factors such as absorption and adsorption of staining agents leading to possible discoloration.^{11,12}

Staining of various denture bases is caused by the natural and synthetic colorants present in the food.¹¹ Synthetic food colorants like Erythrosine, Tartrazine and sunset yellow are used in continental cuisines to make jam, jellies, candies, puddings, ice-creams etc.¹³, however herb based spices like turmeric (HALDI), nutmeg (JAYPHAL), chilli (MIRCH), bayleaf (TEJ PATTA), cinnamon (DALCHINI), cardamom (ELAICHI), GARAM MASALA, black pepper (KALI MIRCH), clove (LAUNG), cumin (JEERA) and coriander (DHANIYA) have been used traditionally in the Indian kitchens.^{14,15} The GARAM MASALA most commonly use in Indian cooking, is enlisted in oxford advanced learner's dictionary and has been explained as a spice mixture used in Indian cookery. The word is adapted from urdu language where 'GARAM' stands for 'hot/pungent' and 'MASALA' stands for 'spices'.¹⁶

Color perception varies from person to person. Visual color assessments are caused by physiological and psychological responses to radiant energy stimulation. Difference in color perception are because of many factors which can not be controlled. Instrumental measurement can quantify color and allow the communication to be more effective.¹⁷ The Commission Internationale de l'Eclairage Lab

(CIEL*a*b*) system is an international standard for color measurement. A spectrophotometer can measure color differences much smaller than detected by human eye. Therefore, the clinical relevance of color changes record must be evaluated by the spectrophotometer.

This study is aimed to evaluate color stability of flexible denture base material after exposure of GARAM MASALA for particular duration using reflectance spectrophotometer.

Materials And Method

The flexible denture base material (Valplast International Corporation, U.S.A.) used in this study. Thirty samples were prepared. The size of each sample was 15×15×2 mm. Acrylic sheet was used for making the pattern of the samples and patterns were processed following the manufacturer instructions in injection molded flask (Valplast International Corporation, U.S.A.). The samples was deflasked and finished with tungsten-carbide trimmers and 120 and 220 grit sandpaper followed by 600 and 800 sand paper and polished with pumice on a black brush, followed by a slurry of tin oxide (fig-1).

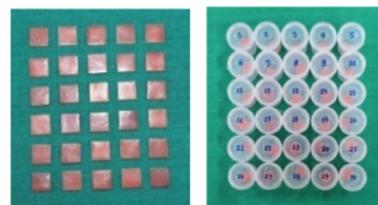


Figure 1

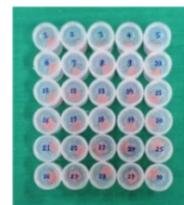


Figure 2

The Garam Masala solution was prepared by pouring of 10 gm of garam masala powder into 500 ml. boiling distil water and simmered for 5 minutes. It was allowed to cool for 10 minutes and then filtered through a piece of gauze.

The prepared 30 samples of flexible denture base material were then kept in their respective plastic jars and numbered them and evaluated for color at baseline (day 0) before immersion in garam masala solution. The prepared Garam Masala solution was poured in jars of 30 samples. The samples were immersed in solutions and these solutions were changed every day (fig-2). The samples were taken from solution after 15 days and cleaned with distilled water and then blotted dry with tissue paper before the color evaluation. The color evaluation were performed using reflectance spectrophotometer (Dual Beam Spectrophotometer for Color Measurement, SS 5100 A d/8, Premier color scan industries limited, Mumbai) and further color evaluation were performed at 30th days. The mean of color change of each sample was calculated with the use of C.I.E. L*a*b* uniform

color scale.

The color difference is calculated from the means using the following formula:

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$$

*L corresponds to lightness or darkness.

*a corresponds to redness or greenness.

*b corresponds to yellowness or blueness.

where ΔL , Δa , Δb are the differences in L, a, b values of the samples before and after the immersion in the colorants.

The value of color change is measured to National Bureau of Standards (NBS unit)¹⁸ using this formula: **NBS units = $\Delta E \times 0.92$**

Critical remarks of NBS units are:

- 0.0–0.5 (trace),
- 0.5–1.5 (slight),
- 1.5–3.0 (noticeable),
- 3.0–6.0 (appreciable)
- 6.0–12.0 (much) and
- ± 12.0 (very much).

Observation

To evaluate the effect of garam masala on the color stability of flexible denture base material samples (thermoplastic nylon), one way ANOVA test was carried out. As the results were statistically significant ($p = 0.05$) Multiple comparison test (Tukey's Analysis) was done subsequently. Critical remarks of color difference according to NBS units are shown in Table 1.

Table -1 : Critical remarks according to NBS units

Time period of staining	ΔE	NBS Units	Critical remarks of color difference (according to NBS units)
ΔE with garam masala at 15 days	5.56	5.11	Appreciable : Prominent change
ΔE with garam masala at 30 days	6.56	6.03	Much : Excessively marked change
ΔE with garam masala between 15 and 30 days	1.80	1.66	Noticeable : Perceivable change

Results

- Mean color difference (ΔE) of flexible denture base material samples after immersion in garam masala solution for 15 days was found to be 5.56.
- Mean color difference (ΔE) of flexible denture base material samples after immersion in garam masala solution for 30 days was found to be 6.56.
- Mean color difference (ΔE) of flexible denture base material samples after immersion in garam masala between 15 days and 30 days was found to be 1.80.
- Mean difference of L^* value at interval 0,15 and 30 days is $p = 0.005$ which is found statistically significant ($P < 0.005$).
- Mean difference of a^* value at interval 0,15 and 30 days is $p = 0.001$ which is found statistically significant ($P < 0.005$).
- Mean difference of b^* value at interval 0,15 and 30 days is $p = 0.001$ which is found statistically significant ($P < 0.005$).

Discussion

The aesthetics of removable denture base depends on shape and quality of the acrylic resin. Considering that denture materials should mimic the natural appearance of supporting tissues and teeth, pigmentation and color stability of such materials are relevant characteristics. In this sense, the color stability may dictate the success or failure of rehabilitation, because aesthetics are main focus of the patient. The subjective evaluation of the prosthesis by the patients is extremely important for their expectation analysis.¹⁹

In this study Garam masala solution was selected because of their extensive use in Indian cuisine and has not been studied yet.

In the present study, the mean color difference ΔE of samples, when immersed in Garam masala for 15 days was found to be 5.56. This value is slightly more than values obtained by Marcelo C. Goiato et al while evaluating the effect of accelerated aging on the micro-hardness

and color stability of flexible resins for dentures.²⁰ They observed the significant values of color alterations $\Delta E = 4.327$ after 504 hours of aging and $\Delta E = 5.752$ after 1008 hours of aging.

In the present study, the mean color difference ΔE of samples in Garam masala for 30 days was found to be 6.56 which is higher than the study done by Mieszko wieckiewicz et al¹⁸ using red wine. They conducted research on physical properties of polyamide-12 versus PMMA denture base material. In this Polyamide-12 (valplast) showed discoloration exceeding a $\Delta E = 4.27$ after 12 days of storage in red wine and 36 days of storage in coffee $\Delta E = 3.93$. After 36 days in red wine color alteration $\Delta E = 6.52$.

In the present study, the mean color difference ΔE of samples in Garam masala for 30 days is also similar to Nurdan et al study.²¹ In this study, Nurdan et al evaluated discoloration of polyamide material in coffee solution showed discoloration $\Delta E = 7.28$ after 7 days.

In the present study the results indicate that ΔE value (6.56) was higher than zero for all samples which represents a color alteration and the samples became darker (decrease of L^*) and greenish (decrease of values of a^*) and yellowish (increase in values of b^*) in garam masala.

This study showed discoloration of samples by garam masala has been attributed to the presence of yellow colorants. The effect of these colorants is similar to the brown colorants present in coffee and tea. The colorants have different polarity than denture base and probably might get absorbed due to compatibility of the polymer phase with the colorant.

Polyamide-group denture base resins are subjected to water sorption between molecular chains due to the hydrophilicity of the many amide bonds that form the main chains of the resins, resulting in high water sorption rates.⁸

Materials with high hydrophilicity are prone to pigmentation by the hydrophilic colorants in water-soluble solutions. In our study Garam masala solution is hydrophilic which gets easily absorbed by samples and showed significant color change.

The porosity and roughness of a material surface are influenced by polymerization and polishing methods. Since polyamides have been reported difficult to finish and polish due to their low melting temperature. Fraying at the margins of the polyamide samples was avoided by use trimmer and polisher at slow speed.

Goldstein and Schmitt state that ΔE values greater than 3.7 are not clinically acceptable. Based on the results of this study, flexible denture base material (thermoplastic nylon) undergoes a major color change when immersed in coloring agent (Garam masala). So the use of flexible denture base material is restricted where conventional denture base resin are not advisable like elderly and handicapped patients, patients with restricted mouth opening, severe soft and hard tissue undercuts, and those patients who are allergic to acrylic resin and metal. Thus, caution is needed regarding its indication for making denture bases.

This study presented the combine effect of Garam masala, further long term studies are recommended for individual component of this Garam masala.

Conclusion

After statistical analysis and thorough discussion, within the limitations of the present study, following conclusions were drawn:

- The mean color difference (ΔE) of flexible denture base material samples after immersion in garam masala solution (from values of samples before immersion) for 15 days was found to be 5.56, which is appreciable color change according to NBS unit.
- The mean color difference (ΔE) for 30 days was found to be 6.56, which is much color change according to NBS unit.
- The color difference (ΔE) between 15 days and 30 days was found to be 1.80 that is noticeable color change.

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