

EFFECT OF TWO DIFFERENT CLEANSING AGENTS ON COLOR STABILITY OF THERMOPLASTIC DENTURE BASE MATERIAL

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ABSTRACT

Purpose: Researchers tried to improve the mechanical properties of poly methyl methacrylate (PMMA) denture bases. Development of alternative materials such as thermoplastic denture base materials as polyamide had also been reported in the literature, however, it has not been well studied regarding color stability. The aim of this in vitro study was to evaluate the effect of two different cleansing agents on color stability of thermoplastic denture base material. **Materials and methods:** Thirty samples were fabricated from polyamide (Vertex Thermosens thermoplastic denture base material). Samples were divided into Three groups: 10 each. Group I (control group): soaked in distilled water, Group II: soaked in Corega cleansing agent and Group III: soaked in Efferdent cleansing agent. **Results:** Statistical non-significant results were found. A slight non-significant effect on color stability was found more with Efferdent than Corega cleansing agent and water. **Conclusion:** Disinfecting polyamide denture base material (Vertex Thermosens) could be done safely with Corega and Efferdent cleansing agents.

KEYWORDS: Polyamide, cleansing agents, color stability.

INTRODUCTION

Denture base materials should be biocompatible with the oral tissues, having supreme esthetics and excellent mechanical properties concerning modulus of elasticity, high impact strength, hardness and flexural strength, bond well to artificial teeth and lining materials and high dimensional accuracy¹.

Polymethyl methacrylate [PMMA] was introduced as denture base material and was proved to be more superior over other denture base materials concerning properties.² It became so popular that

during 1940s' nearly all dentures were made from acrylic resin.

Thermoplastic resins were used in dentistry in different situations for a very long period of time. They composed of polymers of different molecular weights and chain lengths. It is classified to Polyoxymethylene (acetal), thermoplastic acrylic, polycarbonate resin and polyamides (Nylon)³.

Polyamides' denture bases were first introduced at 1950s. Polyamides differ than PMMA as nylon is a crystalline polymer while PMMA is amorphous.

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Nylon lacks solubility in solvents, has high thermal resistance and high strength combined with ductility⁴.

Polyamides fulfill the requirements of ideal denture base polymer that are to have smooth and glossy surface, matching the natural soft tissue appearance. It can be in translucent form with no porosity for excellent esthetic effect and increase patient satisfaction⁵.

Several instruments such as colorimeters, digital cameras and spectrophotometers are used for color measurements in dentistry. The spectrophotometer evaluates visible light through the color spectrum (400–700 nm) and expresses the analysis in a numerical value⁶.

Denture cleansing agents are widely used to prevent colonization by *Candida Albicans* and as antiplaque agent and can be categorized into the following types: enzymes, neutral peroxides with enzymes, (acids, hypochlorites) and mouth rinses.⁷

Denture cleanser contains sodium bicarbonate, potassium caroate citric acid, sodium carbonate, tetra acetyl ethylene diamine, sodium carbonat peroxide, sodium lauryl sulfocetate and sodium benzoate. Corega releases active CO₂ with its antibacterial effect and prevents plaque formation on denture surface.^{8,9} While Efferdent contains sodium perborate, potassium mono sulfate, sodium bicarbonate and has an effective role in prevent and removal of plaque on denture surface.^{10,11}

Change in denture base resin color result in aesthetic problems. Thus keeping color stability of these resins is very important to the long term aesthetics of the denture. Few studies have tested the influence of cleansing agents on color stability of the thermoplastic denture bases. So, the null hypothesis of the current study is that there is no effect of two different cleansing agents (Corega and Efferdent) on color stability of thermoplastic denture base material (Vertex Thermosens).

MATERIALS AND METHODS

In this in-vitro study, thirty samples were fabricated from Vertex Thermosens (**Vertex-Dental B.V. Soesterberg, Netherland**) thermoplastic denture base material and divided into three groups (10 each).

- Group I: samples were soaked in distilled water and considered as control group.
- Group II: soaked in Corega cleansing solution. (**Corega Denture Cleanser Tabs, GSK, Egypt**).
- Group III: soaked in Efferdent cleansing solution. (**Efferdent, Johnson & Johnson, New Brunswick, NY, USA**).

Then the effect of these two cleansing solution on the color stability of Polyamide denture base material was evaluated.

Preparation of metal discs

Samples of the two denture base materials were prepared using laser cut technology in metal disc shape patterns (50±1 mm diameter and 0.5±0.05 mm thickness) following the ADA specifications no. 12.¹²

Samples preparation¹³

Following the manufacturer instructions; the study samples were fabricated using injecting molding technique where the Polyamides was injected into a space created by the metallic disc in a special flask.

The metal disc was flaked in dental stone type IV inside the flask; wax sprue was fixed to the injection channel of the flask. The two halves of the flask were re-assembled and well fastened. After stone hardening; the flask was put in hot water bath with 70°C for 10 minutes. Flask was opened and the remnants of wax were washed out with boiling water. The flask was then preheated for 20 minutes in 90°C water. The polyamide cartridge was also

preheated to 250°C for 16 minutes and injection of the material with 6.5 bars of pressure was done. The complete flask was placed in a boiling water for 30 minutes or in an oven (>100°C) or in. The flask was bench cooled for 20 minutes and it then opened.

The resin samples were separated carefully from the stone, the injection channels were cut off and finishing and polishing of samples were done using special standard finishing and polishing kit of polyamides.

Color stability evaluation ¹⁴

The spectrophotometer and the International Commission on Illumination (CIE) concept were used to carry out this test by measuring the light absorption of each specimen before and after immersion.

The apparatus used in measurements was Agilent Cary 5000 spectrophotometers provided from Agilent Technologies (USA). It was manufactured according to a quality management system certified to ISO 9001.

The basic CIE concept is that all colors can be matched by mixing relative amounts of the three light primaries: Red (X), Green (Y), and Blue (Z).

These can then be transformed to **L**, **a**, and **b**

values. **L**: measure of lightness, **a**: value indicates positions on a red-green axis, (when **a** shows higher positive in value, the color turns more red and when shows more negative in value; the color turns more green) and the **b** value indicates positions on a yellow-blue axis, (when **b** shows high positive in value, the color turns more yellow and when **b** shows more negative in value, the color turns more blue). **Figure (1)**

The equation utilized for calculating color differences in this system:

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

where ΔL , Δa and Δb are the differences in L, a and b values before and after soaking at each time interval. In the current study, only ΔE result was used for analysis.

National Bureau of Standards (NBS) is used to quantify the color change. Critical marks of color difference according to NBS are shown in Table (1). Following formula is used to express NBS units.

NBS unit = $\Delta E \times 0.92$, Where ΔE stands for color change.

Spectrophotometer calibration

The spectrophotometer was Warm up for forty five minutes; the wavelength (580) for example was

TABLE (1) NBS: National Bureau of Standards

Critical remarks of color difference	NBS units
Trace	0.0-0.5
Slight	0.5-1.5
Noticeable	1.5-3.0
Appreciable	3.0-6.0
Much	6.0-12.0
Very much	12.0 \geq

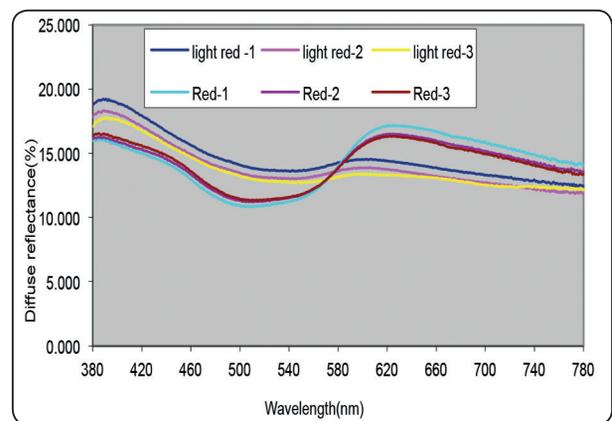


Fig (1): Evaluation of the color of the samples by the spectrophotometer.

selected to be calibrated. The cover was closed with no cuvette in the spectrophotometer holder and start zeroing the spectrophotometer till the displaying screen shows all zero transmittance. A cleaned cuvette three quarterly full of water was prepared, put in the spectrophotometer holder and then the lid closed. The device was started again till the screen displays 100.0% transmittance. These steps were repeated every new wavelength.

The samples were fixed to the spectrophotometer holder and the machine was turned on then the samples were tested. **Figure (2A&B)**

All samples were evaluated for color stability after and before immersion in cleansing agents and water to evaluate the effect of cleansing agents. Data were collected, tabulated and statistically analyzed using one way ANOVA test.

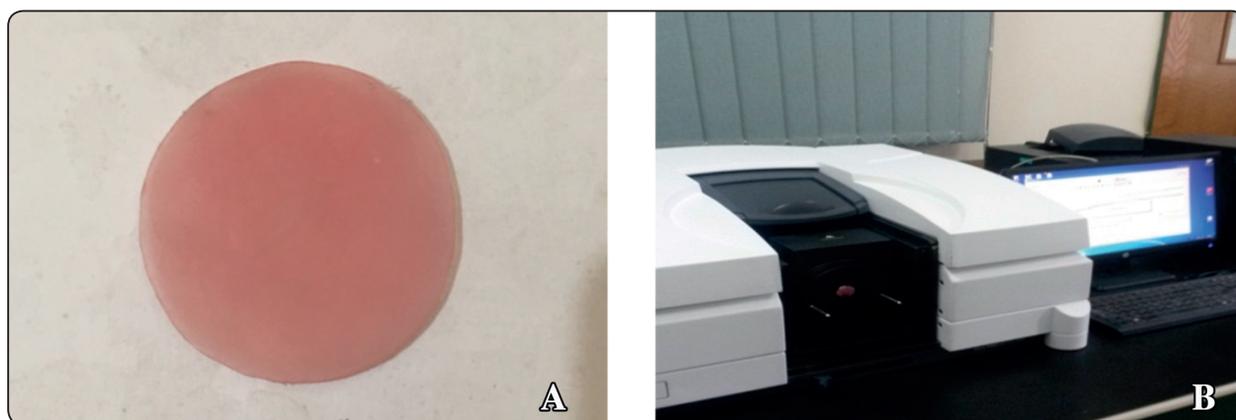


Fig. (2 A&B): Showing the tested sample inside the Agilent Cary 5000 spectrophotometer while the attached screen shows the curve of the color stability.

RESULTS

Comparison of color stability of the Thermoplastic denture base material in different cleansing agents:

The results of comparison between the different groups as regarding color change are shown in Table (2) and Figure 3.

The values of the color changes ΔE of polyamides when immersed in water, Corega and Efferdent showed higher value of color changes for Efferdent followed by Corega while the least color change was reported for water. Comparison between values of color changes showed no statistical significant differences (P-value = 0.835) Fig (3).

TABLE (2): Mean values, SD, and comparison for color changes between different groups.

	Cleansing agents						p-value
	Water		Corega		Efferdent		
Thermoplastic denture base material	Mean	SD	Mean	SD	Mean	SD	
Vertex Thermosens	1.015	0.061	1.062	0.086	1.082	0.0125	0.835

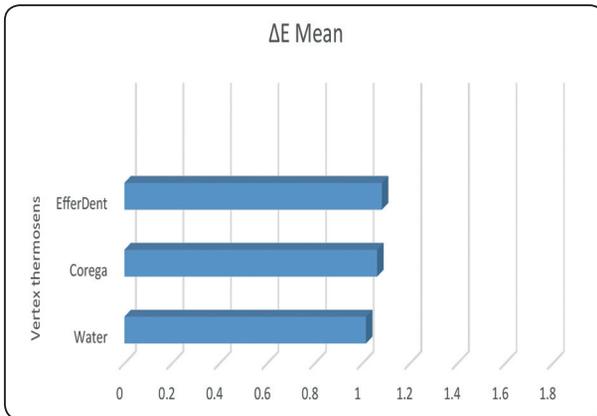


Fig (3): Mean values bar chart of Vertex Thermosens immersed in different cleansing agents.

DISCUSSION

Although Polyamide resins (nylon) were used as denture base material from the early 1950; few studies declared optimum properties of the use of polyamide in laboratory stages. Documentations about these materials that they have flexible and semi-flexible structure, low water sorption and solubility, non-allergic and biocompatible⁴.

The first produced versions of polyamides had disadvantages such as liability to deterioration of color, ability to be stained, high water sorption, development of surface roughness after a month or two and difficult processing, its use was limited to certain situations such as repeated denture fractures, proven allergy to PMMA, obturators for maxillary defects and construction of orthodontic appliances¹⁵.

Revolution in technologies and understanding the properties of material in other fields have improved polyamides, pass its limitations and directed new applications in the fabrication of removable partial dentures, small to medium sized complete dentures, and also occlusal splints¹⁶.

One of the unique advantages of polyamides due to high light transparency are that they reflect the color of underlying gingival tissues; in other words, they have high quality esthetic properties. Beside this property, it is of low porosity; they do not cause

discoloration and smell formation and have high impact resistance. In addition, although they have a low rigidity and when compared to acrylic resins, they have extremely tough properties¹⁷.

In this study, spectral colorimeter by spectrophotometer was used to verify the color changes, it is more widely used than visual assessment digital image processing method in testing color change for the denture base because it can exclude errors due to observers bias and gives more accuracy¹⁸.

Munsell and CIE Lab color systems are commonly used for color difference analysis. CIE Lab color system was used in this study following recommendations of previous study as it is comprised of all colors, including light source colors; further, it does not depend on human perception.¹⁹

Cleaning of the dentures can be accomplished either by mechanical, chemical and combination of both. Chemical disinfection may cause adverse effect on the material, such as denture staining and compromised strength. To avoid adverse effects on the properties of denture base resins, disinfectant must be chosen to have compatibility with the type of denture base material to be cleansed.²⁰

Corega and Efferdent cleansing agents were used for their effectiveness in disinfecting the dentures and their role as antiplaque on denture surface, while distilled water was chosen as a control group as not contained minerals or chemicals affecting the properties of the denture base materials.⁸⁻¹¹

Higher ionic concentration of denture cleansers compared to water resulted in higher release of soluble components leading to loss of soluble component and plasticizers from the denture base. Further absorption of water and other salivary components by the denture base materials leads to color change and surface roughness^{21,22}.

In the current study, insignificant statistical differences were found between Efferdent, Corega and water. Although Corega gives better results

than Efferdent, the difference is of no clinical importance. This difference can be attributed that Efferdent cleansing agent contain potassium mono sulfate and sodium bicarbonate which not contained in Corega that may react with the coloring agents of polyamide denture base material.

CONCLUSION

Based on the limitations of this study, disinfecting polyamide denture base material may be performed safely with denture cleansing agents as they had non statistical significant effect on color stability.

Conflict of interest:

The Author declares that he has no beneficial interest with any of the tested commercial products.

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