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The Influence of Certain Dietary Factors on the Colour Durability of Composite Prosthetic Materials

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Abstract

The objective of this study was to suggest the use of spectrophotometrical method for mesurement, controll and predict the discoloration of prosthetic materials. The discoid samples of ceromer Targis (Ivoclar) and the ceramic composite Gradia (GC) were placed in coffee, tea and dark fruit juice of pH ranging from 4 to 8. Measurements were conducted with a spectrophootometer Specol (Carl Zeiss)) used to measure the monochromatic coefficients of reflected light. Direct measurements were used to determine colour coefficients L* a* b* of the samples according to CIE (Commision Internationale de l`Eclairage) for two different light sources: artificial (A type) and daylight fluorescent tube (D 65 type). Results were compared with the physiological scale of human colour perception of the CIE L*a*b* system. It was found that the pH of the liquids used in this study had a varied, a statistically significant ($p<0.05$) influence on the changes of the tested prosthetic materials (tendency to discolour to an extent detectable by the human eye). Time dependent changes of colour investigated in our study allow for predicting a proper colour match in dental practice.

Keywords: prosthetic materials, colour, spectrophotometry

Introduction

Colour match and colour durability are material properties that significantly affect the esthetic result of prosthodontic treatment. Dental materials may have various tendencies to discoloration caused by certain dietary habits.

Experimental procedures

Samples of two composite prosthetic materials used for fixed dentures; Targis (Ivoclar) and Gradia (GC) were examined. 24 discoid specimens of each material, 6 mm in diameter and 1.5 mm thick (shade A2) were prepared. Light-cured composites were applied to a split ring between two glass slabs and cured according to the manufacturers` directions. All specimens were finished with a 1000 grit paper to standardize their surface [1]. Measurements were carried out before and after immersion of material samples in solutions prepared on the basis of popular beverages such as coffee, tea, dark fruit juice and didistilled water. The samples were evaluated following immersion in solutions of pH 4,6,8, which is most frequently found in the oral cavity. Measurements of colour parameters were taken after 0.5h, 2h, 5h, 15h, 30h, 60h of immersion in the experimental solutions. A specially prepared measurement system including a spectophotometer, (Specol Carl Zeiss) with a fiberoptic adapter designed for photometric measurements allowed for measuring the coefficients of light reflection. The system contained a double beam ratio integrating sphere reflectometer that collected specular and diffuse reflectance [2]. The international white

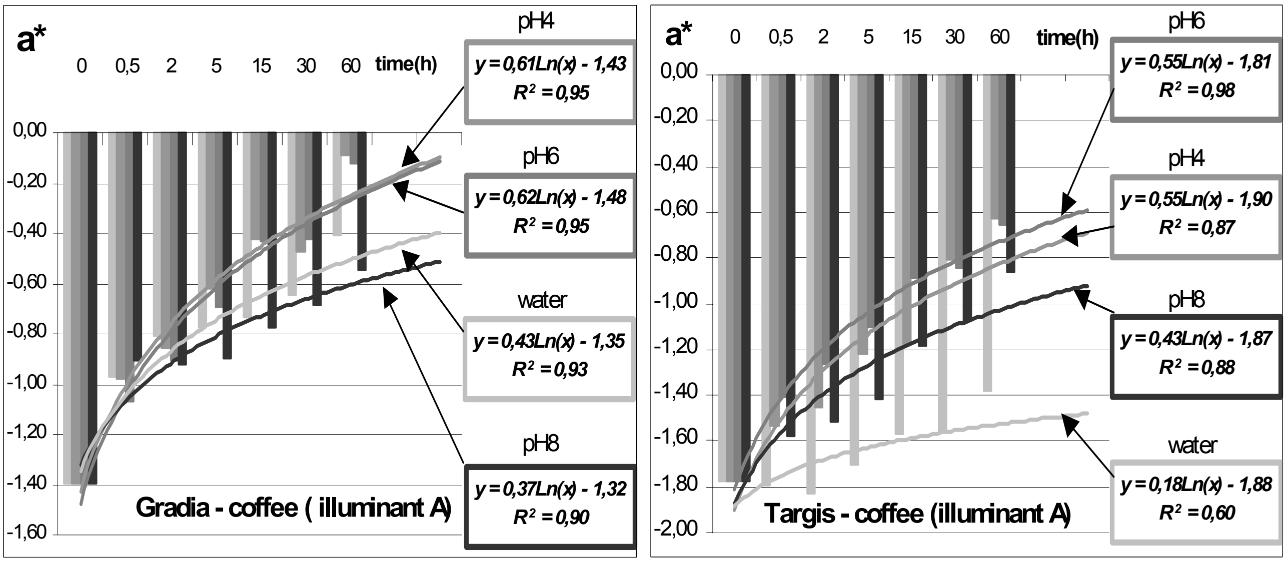

Fig. 1. Examples of a* parameter for Targis and Gradia caused by the activity of coffee.

Table 1. Changes of overall colour ΔE and parameters ΔL*,Δa*, Δb* after 60 h.

SD<0,2	**Gradia**				**Targis**			
	ΔL*	**Δa***	**Δb***	**ΔE**	**ΔL**	**Δa***	**Δb***	**ΔE**
Water	-1,95	0,97	0,23	2,19	-1,22	0,33	0,53	1,37
Juice pH4	-5,02	1,74	1,43	5,33	-1,94	0,41	-0,63	2,08
Juice pH6	-5,93	0,99	0,07	6,02	-2,84	0,60	-0,05	2,91
Juice pH8	-2,95	0,65	0,94	3,17	-3,23	0,58	0,51	3,33
Coffee pH4	-2,66	1,30	2,91	4,15	-3,47	1,14	2,08	4,20
Coffee pH6	-2,61	1,27	2,07	3,57	-2,10	1,12	1,90	3,04
Coffee pH8	-2,12	0,85	1,67	2,83	-1,15	0,91	0,82	1,68
Tea pH4	-1,93	2,00	2,40	3,68	-1,51	1,17	1,36	2,35
Tea pH6	-2,45	2,33	2,43	4,16	-1,85	1,65	0,60	2,55
Tea pH8	-1,29	1,12	1,37	2,19	-2,34	0,61	0,63	2,50

Changes easily visible Δ(L*,a*,b*,E*)>6
Changes cleary visible 6>Δ(L*,a*,b*,E*)>3
Changes poorly visible 3>Δ(L*,a*,b*,E*)>1,7
Changes not visible Δ(L*,a*,b*,E*)<1,7

standard, 156D (GUM) – 0.5360, was used to verify calibration of the system. All specimens were scanned from 380 to 780 nm with a data interval of 5 nm. Reflectance measurements were stored in digital form and utilized for CIE L*a*b* values for a 2^0 standard observer and for illuminants D65 (day light) and A (artificial light). Changes in overall colour (ΔE*) were calculated as follows: $\Delta E^*=[(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2]^{0.5}$ [1, 3]. Particular attention was paid to the possibility of a mathematic description of the colour change as a function of time. The changes of colour ΔE data after 60 hours were analysed using the three-way analysis of variance (ANOVA) with respect to the following factors: liquids (water, tee, coffee, juice of dark fruits), pH and materials (Gradia, Targis) [4, 5].

Results

Mean values of ΔL*, Δa*, Δb*and ΔE* after 60 hours of immersion in testing liquids are shown in Table 1. Standard deviations for all the results were less then 0.2 of L*a*b* space units. The darker the area representing the results in the table, the greater the discoloration. The color perception thresholds were defined according to the recommendations of CIE [6]. The three-way ANOVA showed significant differences ($p<0.05$) among pH of solutions and materials. No differences were found between testing solutions (coffee, tea and juice of dark fruits). The interactions between the factors pH, liquids and materials were significant ($p<0.05$).

The results of measurement of discoloration after 60 h indicate that coffee, tea and juice discolor clearly visibly for an average observer (6>ΔE>3). Didistilled water discolours Gradia poorly visibly (ΔE>1.7), and Targis not visibly.

The materials were discoloured the most when immersed in experimental solutions of pH = 4 and pH = 6. The graphs in Fig. 1. present examples of a* parameter for Targis and Gradia caused by the activity of coffee. 48 different processes of discoloration of the samples for changes of independent colour parameters L*(brightness), a*, b*(hue and chroma), and overall colour E* were examined. For 100% of the cases, of the independent processes the discolorations could be described with a function of: $\Delta E = a \ln t + b$. In 50% of the cases the coefficient of regression was above 0.9 which is statistically considered a very good estimation. The values of coefficients of regression R^2 below 0.6 were obtained only in the case of didistilled water.

Conclusions

Prosthetic materials have a tendency to discoloration to an extent detectable by the human eye. The high value of coefficients of regression, e.g., 0.9 creates conditions for a mathematic prognosis of complete long-term discoloration.

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