EVALUATION OF SURFACE HARDNESS AND COLOR STABILITY OF MAXILLOFACIAL SILICONE ELASTOMER MODIFIED WITH ZNO NANOPARTICLES: THE EFFECT OF ARTIFICIAL AGING

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Abstract: Maxillofacial prostheses undergo significant changes in their structure and appearance during working life, mainly due to aging caused by exposure to extraoral conditions. Changes in color and surface, such as hardness, are often the main reasons for prosthesis replacement, as these are changes that are visually very noticeable, due to the specific facial location of the prosthesis. The aim of this study was to investigate the effects of incorporation of different weight percentages of ZnO nanoparticles into a commercial, colored maxillofacial silicone elastomer, on the surface hardness and color stability of silicone material subjected to artificial aging. The tested properties were selected because of their important clinical significance. Keywords: maxillofacial prostesis, silicon elastomers, ZnO nanoparticles, surface hardness, color stability.

INTRODUCTION
Maxillofacial prosthetics representing a science and art of anatomical, functional, and cosmetic reconstruction by means of artificial replacement of head and neck structures that are missing or defective. Silicone elastomers are the materials most commonly used to make these prostheses. In maxillofacial area, these materials are exposed to various extraoral environmental factors, that can adversely affect the mechanical and physical properties of this material. Two major problems, associated with maxillofacial prostheses, used to rehabilitate patients with orofacial defects are: 1) the degradation of static and dynamic physical properties of elastomers, and 2) discoloration of the prostheses in a service environment. Scientific studies have found satisfactory results by incorporating different kind of nanoparticles (NPs) into maxillofacial silicone elastomers, in terms of protecting such materials from degradation.

MATERIAL AND METHODS
Color evaluation were performed on 60 colored silicon specimens, divided into three groups: I - spaciements modified with 1% ZnO nanoparticles, II - spaciement modified with 2% ZnO nanoparticles, III - control non modified spaciements. Outcomes were measured before and after accelerated aging for color changes as well as for surface hardness values.

Measurement of color change
The values of color changes of samples in all examined groups were exposed to sunlight for 6 hours every day, during the period of maximum intensity of UVA and UVB rays - between 10 am and 4 pm, for a month. Measurement of color and surface hardness was performed after a period of 10 days, 20 days and 30 days.

Surface hardness measurement
The values of hardness were performed initially and after aging periods (1, 20 and 30 days), by using a digital durometer. The measurement was performed at 5 different points on the surface of the sample, and the mean value was recorded as the hardness of a particular sample.

RESULTS
Results showed that the presence of nanoparticles influenced the properties of the assessed groups. Modification of facial silicone by ZnO nanoparticles increased hardness values. The highest values of surface hardness were observed for the groups with addition of 2% ZnO NP, group without NP showed the lowest values of surface hardness. ZnO NP modified specimens showed minimal or no color change, representing significant color stability after being subjected to outdoor weathering. Most of the results of color change in all examined groups are above 3.3 DE units, which indicates that the color change after the period of artificial aging can be visually noticeable. According to the results of the paired t-test, there is a statistically significant difference between the hardness of the samples of all three examined groups before and after exposure to artificial aging (p < 0.001).

Effect of ZnO nanoparticles concentration
Comparing the results of color change in the examined groups after 10 days of artificial aging, it was shown that group II with 2% ZnONPs shows the lowest value of color change. After 20 and 30 days of aging, group II with 2% ZnONPs shows the least color change. Comparing the hardness of the tested samples, it was shown that group II with 2% ZnONPs shows the highest hardness value. After 20 and 30 days of aging, group II with 2% ZnO still shows the highest hardness value, followed by group I with 1% ZnONPs and the control group.

CONCLUSION
Based on the findings of this in vitro study, the modification of maxillofacial silicon elastomer material by addition of ZnO nanoparticles can be recommended.

REFERENCES