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Adhesive With L-Arginine-Containing Mesoporous Silica Nanoparticles: Antimicrobial and Physico-Mechanical Properties

D. Jiménez-Díez[1], P. Fernández-García[3], F. Navas[3], M. Garrido[3], V. Morales[3], R. Sanz[3], R. García-Muñoz[3], M. Ruiz-Linares[2], C. Ferrer-Luque[2], A. Loguercio[4], V. Fuentes[1], L. Ceballos[1]

[1]IDIBO Research Group, King Juan Carlos University, Alcorcón, Madrid, Spain, [2]University of Granada, Granada, Spain, [3]King Juan Carlos University, Móstoles, Madrid, Spain, [4]State University of Ponta Grossa, Ponta Grossa, Paraná, Brazil

Objectives To evaluate the effect of addition L-arginine-containing mesoporous silica nanoparticles (Arg@MSNs) into a commercially available universal dental adhesive for anticariogenic purposes, focusing on its antimicrobial and physico-mechanical properties.

Methods Arg@MSNs were synthesized and incorporated into Ambar Universal (AU, FGM) at 2wt% (AU_2%Arg@MSNs) and 5wt% (AU_5%Arg@MSNs). Unfilled AU was used as control (AU_unfilled). Antimicrobial activity of adhesive-coated dentin blocks against a polymicrobial suspension was tested by adenosine trisphosphate (ATP) and confocal laser scanning microscopy (CLSM) assays. For ATP test, microorganisms attached to the adhesive surface and microorganisms in the polymicrobial suspension were quantified as relative light units (RLU) after 4 and 6 weeks, respectively (n=17). For CLSM analysis, percentage of viable cells in each stack was determined after 3 weeks (n=20). Additionally, the following physico-mechanical properties were determined: ultimate tensile strength (UTS), flexural strength (FS), elastic modulus (E) after 24h in distilled water (DW) (n=10); water sorption (W_{SP}), water solubility (W_{SL}), mass change (MC) after 7 days in DW (n=5); Vickers microhardness (VHN) after 24h in dry conditions and after 12h softening in absolute ethanol (n=5); and degree of conversion by ATR-FTIR (DC) (n=5). ANOVA with post hoc Tukey test and Kruskall-Wallis test with Bonferroni correction were applied (α=0.05).

Results Mean values (standard deviations) are shown in table. No differences in microorganisms attached were detected for any adhesive, however, AU_5%Arg@MSNs demonstrated a significant reduction in microorganisms in polymicrobial suspension and viable cells. Addition of Arg@MSNs at both concentrations tested did not affect UTS, FS, W_{SP}, MC, VHN and DC. Nevertheless, it resulted in increased EM and decreased W_{SL}. Also, AU_5%Arg@MSNs experienced lower softening in ethanol compared to other adhesives.

Conclusions The addition of Arg@MSNs in AU, especially at 5%, seems to enhance the antimicrobial activity without compromising physico-mechanical properties, even, improving W_{SL} and softening in ethanol.