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Dental Composite With Silanized Nanofiller Providing Anti-Bacterial Potential

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Objectives Although dental composite is routinely used in daily dental practice, composite restorations have a relatively short lifespan and are vulnerable to caries recurrence. This study aimed to design and prepare experimental composites with anti-bacterial potential based on nanoparticles that can release antibacterial molecules upon gradual surface wear.

Methods Large-pore mesoporous silica (MSN-SiO_2) was loaded with the antibacterial agent cetylpyridinium chloride (CPC). Non-silanized nanoparticles and nanoparticles silanized with two silane bifunctional monomers (dimethyloctadecyl[3-(trimethoxysilyl)propyl]ammonium chloride; 3-(trimethoxysilyl)propyl methacrylate), being referred to as CPC@MSN-SiO_2 and S_CPC@MSN-SiO_2, were investigated by micro-Raman spectroscopy (μRaman) and powder X-ray diffraction (XRD). To determine surface area and volume of the nanoparticles, N_2 adsorption-desorption isotherms were collected by a gas adsorption analyzer. Thermogravimetric analysis (TGA) was used to determine CPC-loading and nanoparticle-silanization degree. Different concentrations (0-20wt%) of CPC@MSN-SiO_2 and S_CPC@MSN-SiO_2 were added to conventional silanized barium-borosilicate glass filler, prior to being mixed into an existing experimental BisGMA/TEGDMA resin-matrix formulation to achieve a final 70wt% filler loading. Multi-species oral biofilms were grown on experimental composite discs for 24h and 96h, upon which the bacterial viability was analyzed by qPCR. Flexural strength was measured using four-point bending.

Results μRaman/XRD confirmed successful CPC-loading of MSN-SiO_2, as was confirmed by detection of the CPC-specific pyridine-ring. Weight loss due to decomposition of organic substances of about 18.2wt% for CPC and 3wt% for silane was recorded by TGA. qPCR showed significant inhibitory effects of experimental composites incorporating 20wt% S_CPC@MSN-SiO_2 on *S. mutans* and *S. Sobrinus*. No significant difference in flexural strength between a 20wt% S_CPC@MSN-SiO_2 and control (containing pure 70wt% barium-borosilicate glass filler) composite was recorded.

Conclusions The developed experimental composites incorporating novel functional S_CPC@MSN-SiO_2 nanofiller revealed promising antibacterial potential against cariogenic bacteria, which could extend the clinical lifespan of adhesive composite restorations.