

Can Oral Bacteria and Mechanical Fatigue Degrade Zirconia Dental Implants In Vitro?

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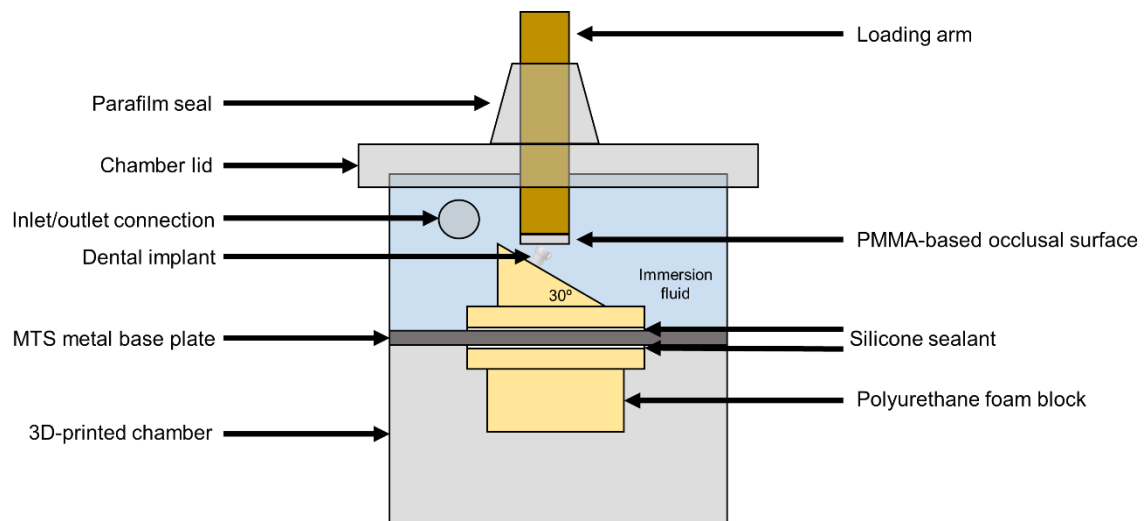


Figure S1. Schematic of test fixture and 3D-printed chamber used for fatigue testing of implants in the synergistic test group (SYN-NC, SYN-PC, SYN-1, SYN-2, SYN-3). Note: dimensions not necessarily drawn to scale.

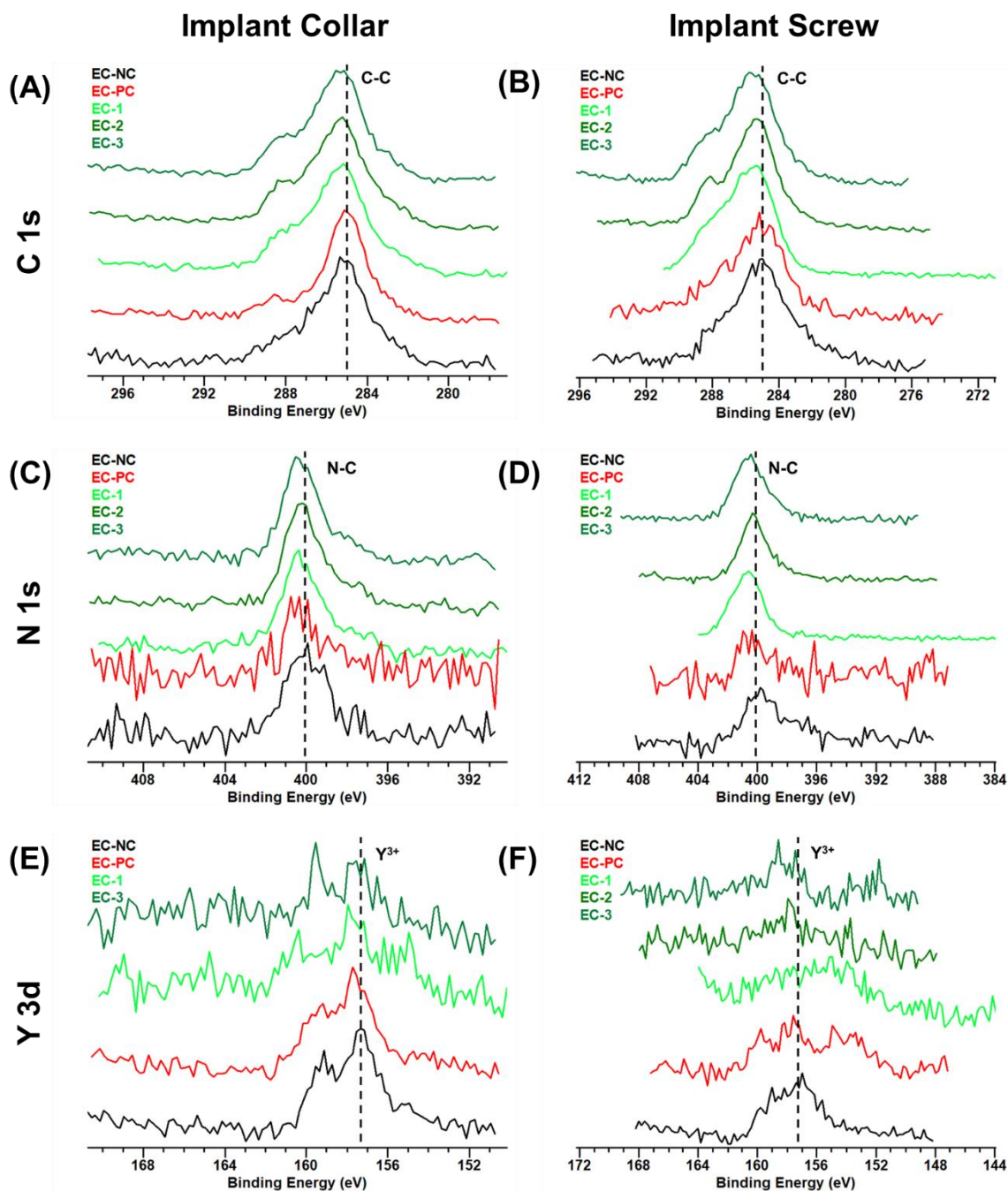


Figure S2. XPS spectra of carbon (C), nitrogen (N), and yttrium (Y) on the surface of ZrO₂ dental implant (A, C, E) collar and (B, D, F) screw regions after 30-day immersion in control or early-colonizing *Streptococcus* polyculture under 5% CO₂ atmosphere at 37 °C.

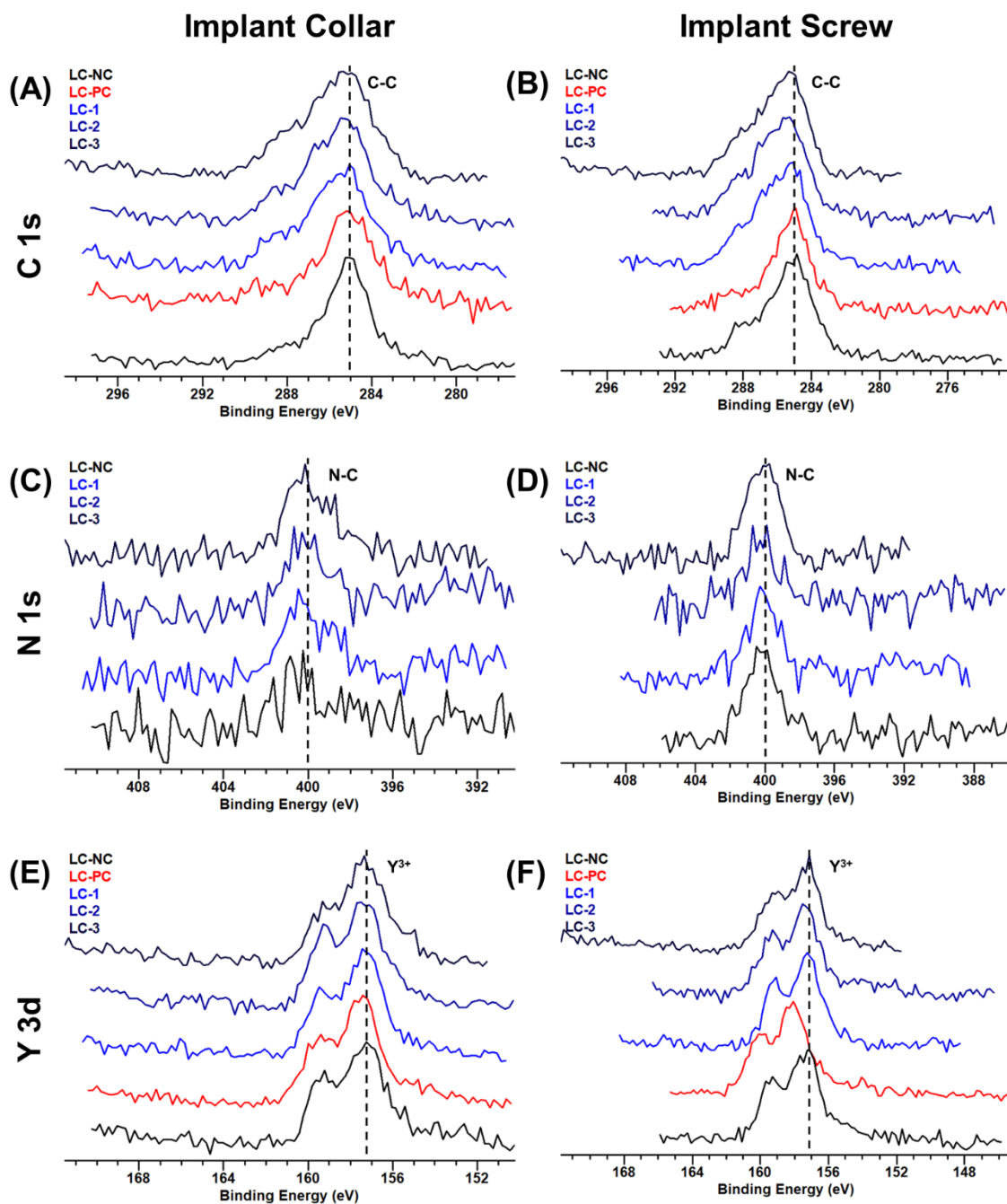


Figure S3. XPS spectra of carbon (C), nitrogen (N), and yttrium (Y) on the surface of ZrO₂ dental implant (A, C, E) collar and (B, D, F) screw regions after 30-day immersion in control or late-colonizing polyculture of *P. gingivalis* and *A. actinomycetemcomitans* under anaerobic conditions at 37 °C.

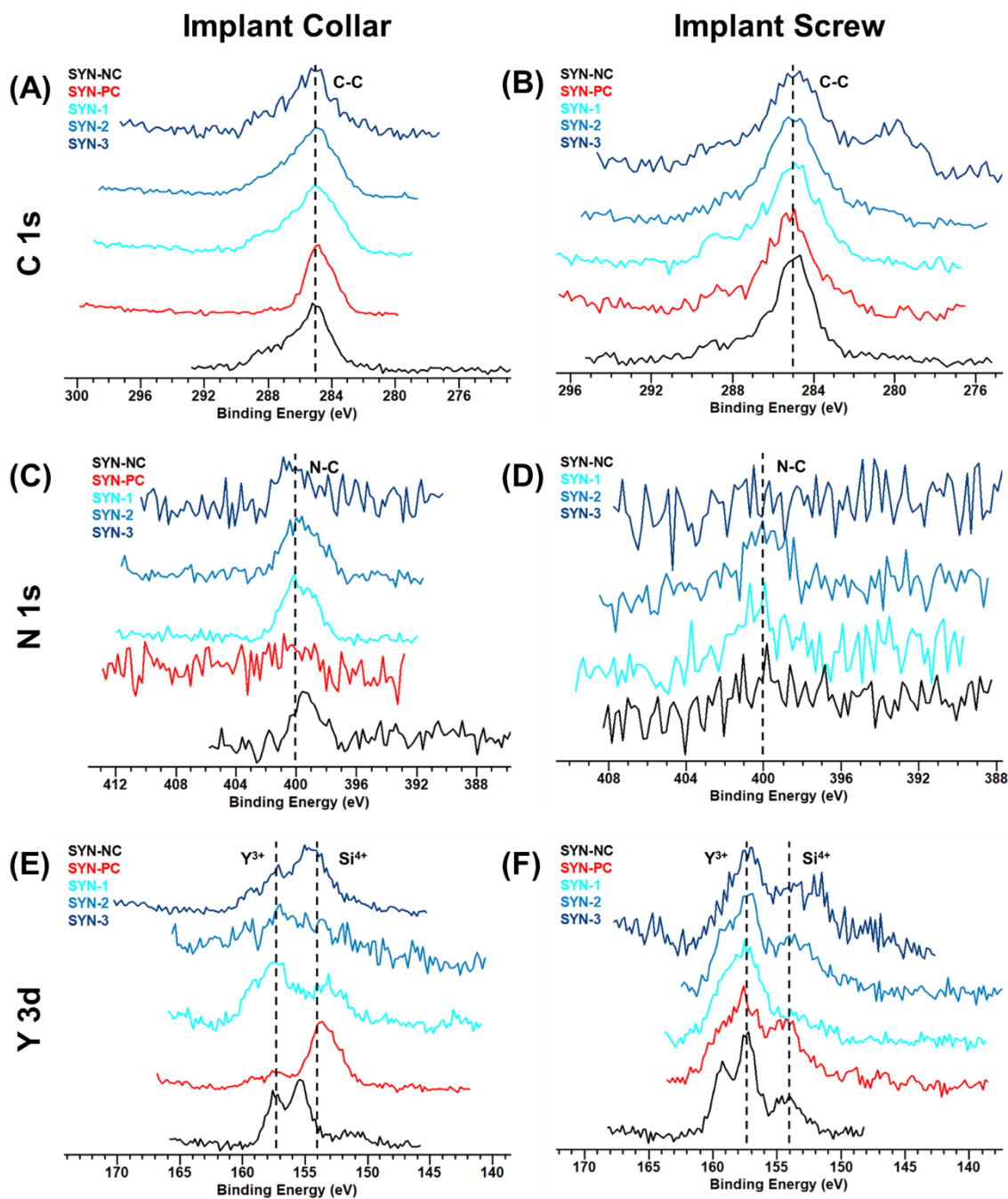


Figure S4. XPS spectra of carbon (C), nitrogen (N), and yttrium (Y) on the surface of ZrO₂ dental implant (A, C, E) collar and (B, D, E) screw regions after immersion in control or polyculture of *Streptococcus* species and *A. actinomycetemcomitans* while subjected to 2 million loading cycles at 4 Hz under ambient air conditions at 37 °C.

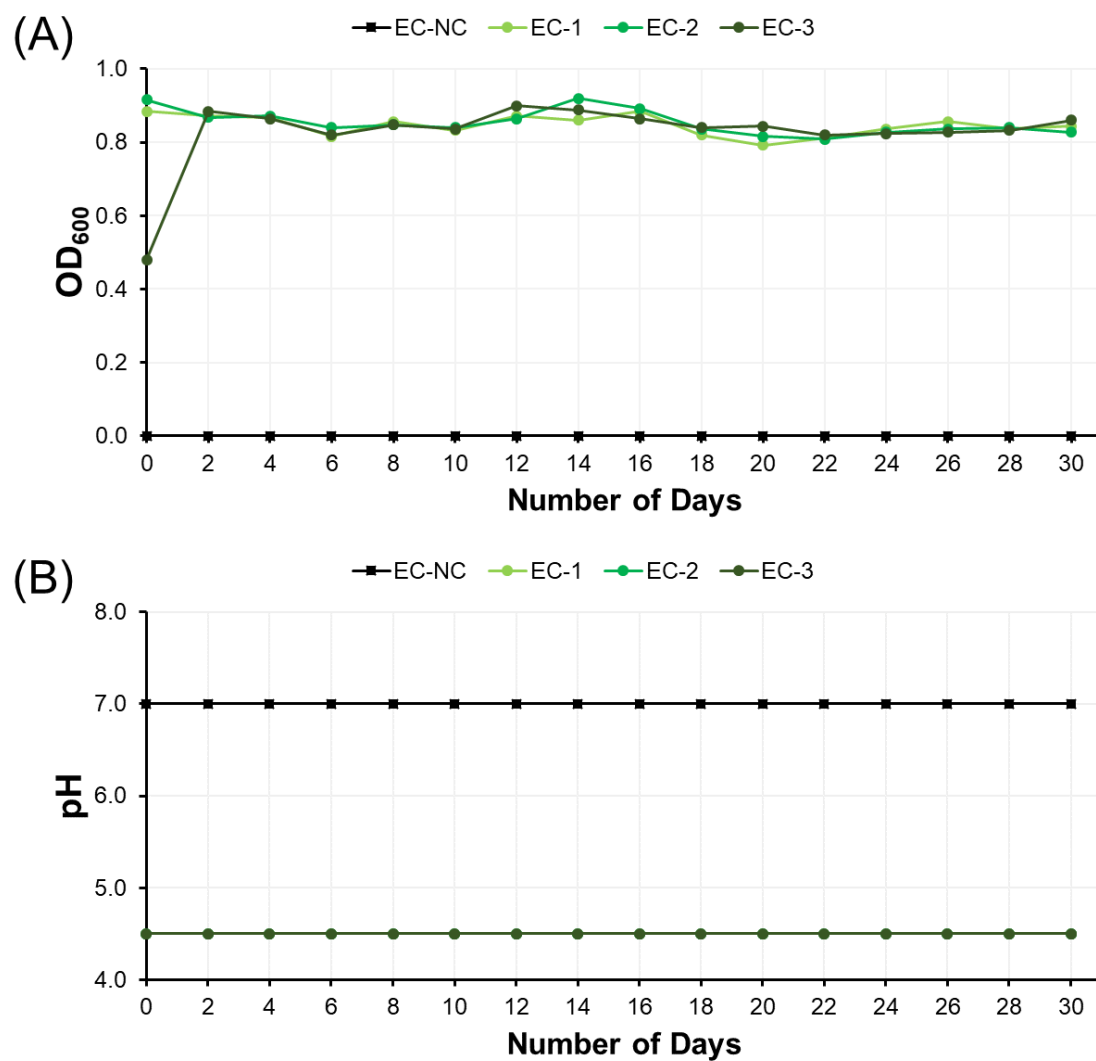


Figure S5. (A) Optical density reading at 600 nm wavelength and (B) pH of negative control (EC-NC) and ZrO₂ dental implants (EC-1, EC-2, EC-3) immersed in early-colonizing *Streptococcus* polyculture under 5% CO₂ for 30 days at 37 °C.

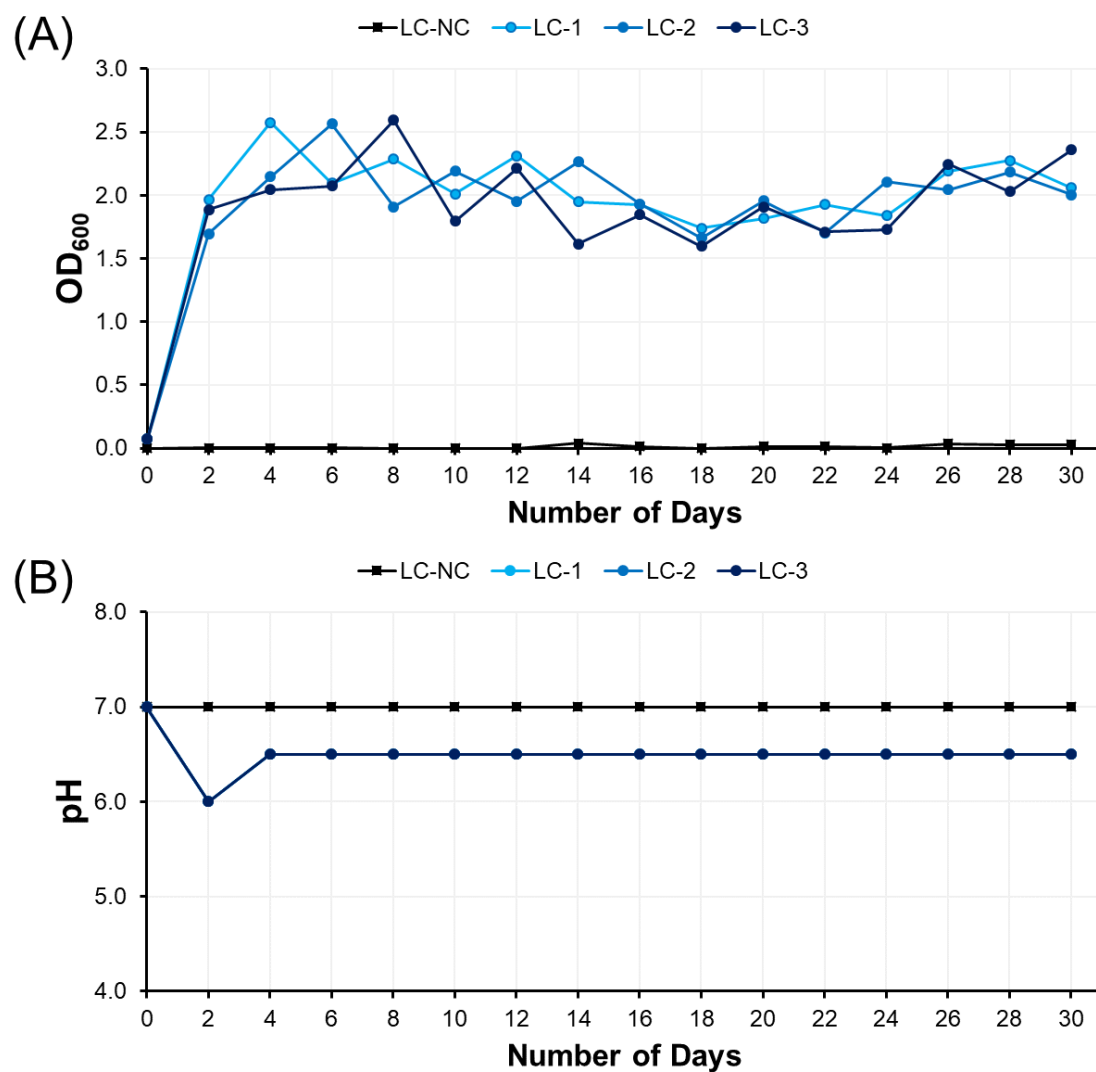


Figure S6. (A) Optical density reading at 600 nm wavelength and (B) pH of negative control (LC-NC) and ZrO₂ dental implants (LC-1, LC-2, LC-3) immersed in late-colonizing polyculture of *P. gingivalis* and *A. actinomycetemcomitans* under anaerobic atmosphere for 30 days at 37 °C.