Potentiation of antimicrobial photodynamic therapy with potassium iodide and methylene blue: targeting oral biofilm viability

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Background

→ Antimicrobial photodynamic therapy (aPDT) is a non-invasive, safe and cost-effective technique

→ It has been shown to induce the death of microorganisms by oxidative damage

→ Due to its mechanism of action, aPDT does not generate bacterial resistance

→ aPDT uses a non-toxic photosensitizer to generate reactive oxygen species (ROS) that are cytotoxic after irradiation by visible light with a specific wavelength

→ Association of potassium iodide (KI) to enhance the results of aPDT

Purpose

To assess the impact of combining potassium iodide (KI) with methylene blue (MB) in antimicrobial photodynamic therapy (aPDT) within an oral biofilm formed *in situ.*

Fig 1. Palatal appliance used in the study

Methods

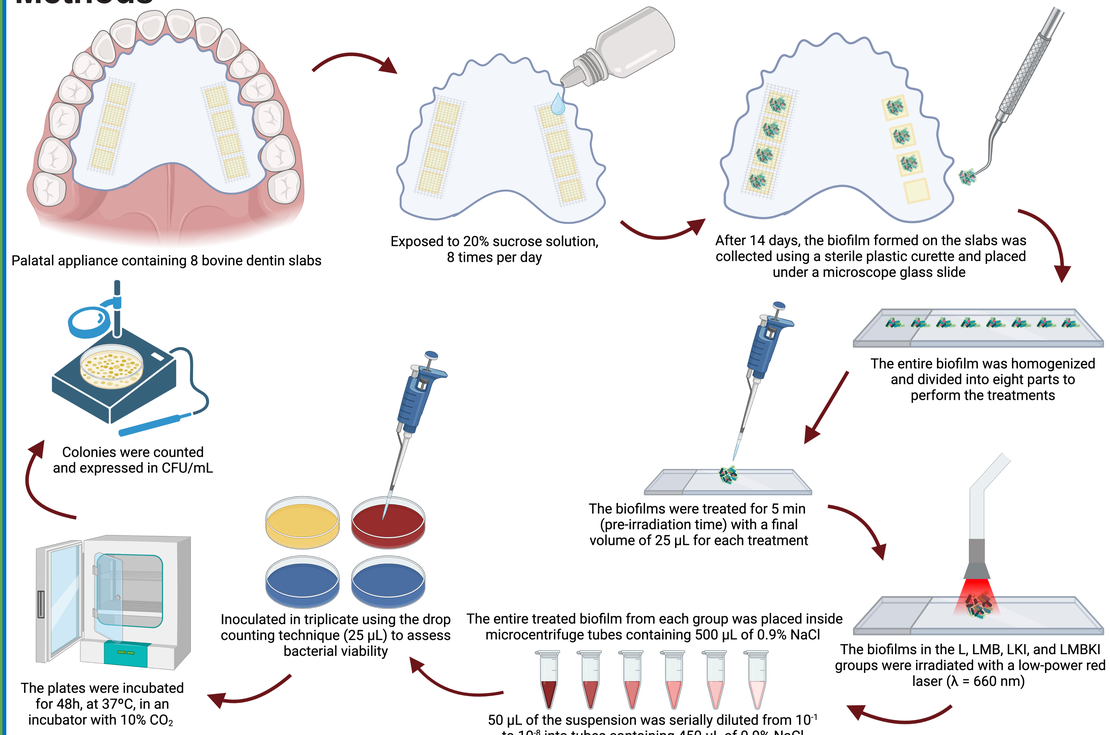

Fig 2. Experimental design of the study.

→ The experimental design comprised a 14-day, single-phase, *in situ* study that was conducted with 21 volunteers.

→ During this period, each participant wore a palatal appliance containing 8 bovine coronary dentin slabs, which were exposed to 20% sucrose solution, 8 times per day, to simulate a high cariogenic challenge.

→ At the conclusion of the intraoral phase, the biofilms formed on the slabs were randomly assigned to 8 groups, according to Table 1.

→ The biofilm was evaluated for microbial viability after the treatments by determining the microorganisms in their colony-forming units (CFU/mL).

Group	Treatment	Red Laser (18 J, 180 s, 112.5 J/cm²)	Methylene Blue 0.005%	Potassium Iodine 75 mM
C	0.9% NaCl (negative control)			
CHX	0.2% Chlorhexidine (positive control)			
KI	KI			+
MBKI	MB + KI		+	+
L	Laser + 0.9% NaCl	+		
LMB	Laser + MB	+	+	
LKI	Laser + KI	+		+
LMBKI	Laser + MB + KI	+	+	+

Table 1. Groups division according to each treatment.

Results

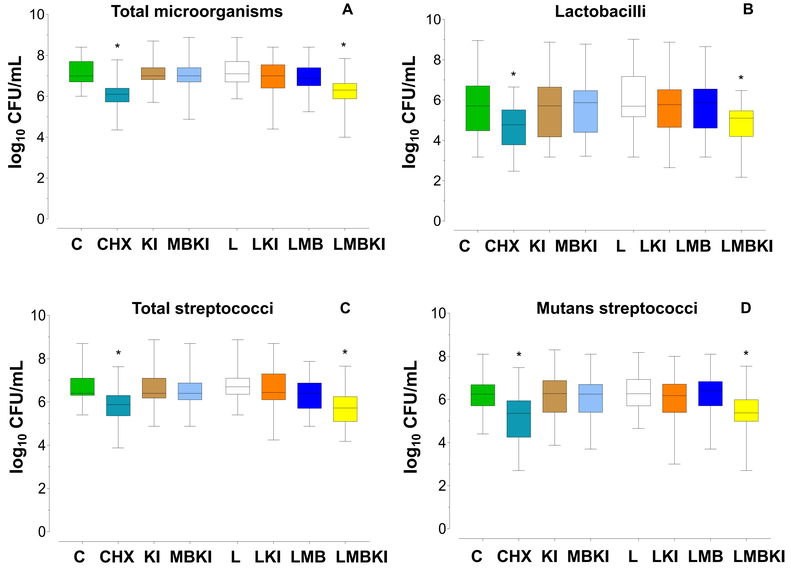

Fig 3. Box plots illustrate the numerical values of the medians for $\log_{10}$ CFU/mL counts pertaining to microbial viability in CFU/mL for each corresponding group. These groups include counts for total microorganisms (A), lactobacilli (B), total streptococci (C), and mutans streptococci (D). Both CHX and LMBKI demonstrate statistically significant distinctions (as determined by Friedman/Dunn tests) compared to the other groups; no distinctions are observed between CHX and LMBKI themselves (* = $P < 0.0001$).

Conclusion

- The combination of KI with MB in aPDT may be advocated as a non-invasive technique for diminishing the viability of polymicrobial oral biofilms, thereby aiding in the management of dental diseases.

References / Supporting Agency

- Reis, A. C. M., Regis, W. F. M., & Rodrigues, L. K. A. (2019). Scientific evidence in antimicrobial photodynamic therapy: An alternative approach for reducing cariogenic bacteria. Photodiagnosis and photodynamic therapy, 26, 179–189.
- Hu, X., Huang, Y. Y., Wang, Y., Wang, X., & Hamblin, M. R. (2018). Antimicrobial Photodynamic Therapy to Control Clinically Relevant Biofilm Infections. Frontiers in microbiology, 9, 1299.
- Vecchio, D., Gupta, A., Huang, L., Landi, G., Avci, P., Rodas, A., & Hamblin, M. R. (2015). Bacterial photodynamic inactivation mediated by methylene blue and red light is enhanced by synergistic effect of potassium iodide. Antimicrobial agents and chemotherapy, 59(9), 5203–5212.

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