

Table S1. *Summary of key findings from in vitro, preclinical, and clinical studies.*

Study	Assay	Test groups	Key results
Antimicrobial studies and dose selection	MIC and MBC	CCE	S. mutans : MIC 0.008%, MBC 0.016% A. actinomycetemcomitans : MIC/MBC 0.004% P. gingivalis : MIC 0.002%, MBC 0.004%
	Sensory evaluation in healthy volunteers (<i>n</i> = 23)	CCE mouthwash (0.005–0.06%)	Bitterness scores : 1.7 (0.005%), 1.9 (0.01%), 2.7 (0.02%), 3.1 (0.04%), and 4.0 (0.06%) Acceptance threshold : 3.0 Selected concentrations : 0.01% and 0.02%
	Time-kill kinetics	0.01% CCE 0.02% CCE	S. mutans/A. actinomycetemcomitans : reduction from 6.0–6.8 to 2.9–4.5 log ₁₀ CFU/mL within 1 h at 0.02% P. gingivalis : complete eradication within 30 s at both concentrations
Preclinical safety studies	Hamster cheek pouch model (Oral mucosal irritation)	Purified water (negative control) 0.02% CCE	Purified water : irritation index 0 0.02% CCE : irritation index 0
	Guinea pig maximization test (skin sensitization)	Purified water (negative control) CDNB (positive control) 0.02% CCE	Purified water : skin sensitization rate 0%; grade I (negative) 0.02% CCE : skin sensitization rate 0%; grade I (negative) CDNB : skin sensitization rate 100%; grade V (extreme)
Clinical efficacy and safety study in participants with self-reported halitosis (<i>n</i> = 73)	Halitosis (H ₂ S and CH ₃ SH)	Vehicle	Week 4 vs baseline: Vehicle / F0.01% / F0.02% H₂S : −9.8%/−65.7% (***)/ −59.5% (***) CH₃SH : −12.5%/−58.8% (***)/−50.0% (***)
	Periodontal outcomes (PI, GI, and BOP)	F0.01%	PI : −18.2%/−54.8% (***)/−55.2% (***) GI : −16.4%/−46.8% (***)/−52.0% (***)
		F0.02%	BOP : −19.0%/−69.7% (***)/−77.3% (***)
	Safety monitoring		No local or systemic adverse events in all groups : No erythema, ulceration, desquamation, staining, or sensory impairment

*** Significant difference from the vehicle group at week 4 (*p* < 0.001).