

Effect of soil on the efficacy of formulated and generic oxidizing disinfectants against biofilms

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INTRODUCTION

- Biofilms that develop on healthcare environment dry surfaces are widespread and have increased tolerance to disinfectants. Hospital grade disinfectants are used to disinfect environmental surfaces but their efficacy is only tested against planktonic bacteria. Killing dry surface biofilm (DSB) bacteria is harder than killing planktonic bacteria (1).
- We compared the activity of formulated oxidizing disinfectants (containing additives like surfactants) and generic (containing only active product) oxidizing disinfectants against *Staphylococcus aureus* DSB.

MATERIALS AND METHODS

- DSB was grown on coupons, in the CDC bioreactor, with alternating cycles of hydration and dehydration (2) (Table 1) and resulted in an average of 2.078×10^6 (Log_{10} 6.30 ± 0.127) CFU/coupon.

Table 1: Culture conditions

48 hr batch phase in 5% TSB followed by 48 hrs dehydration
6 hr batch phase in 5% TSB followed by 66 hrs dehydration
6 hr batch phase in 5% TSB followed by 42 hrs dehydration
6 hr batch phase in 5% TSB followed by 66 hrs dehydration

- Disinfectants were peracetic acid (Surfex and Proxitane), hydrogen peroxide (Oxivir and 6% H_2O_2 solution) and chlorine (Chlorclean and sodium dichloroisocyanurate [SDIC] tablets) based and their composition is shown in Table 2. All disinfectants were dissolved or diluted in artificial hard water (0.304g anhydrous CaCl_2 and 0.065g anhydrous MgCl_2 in distilled water to make one litre).

Table 2: Test disinfectants and their components

Product	Composition	At use concentration
Formulated products		
Surfex powder	Sodium percarbonate 49%	1100mg/L hydrogen peroxide
	Tetraacetylenediamine 27%	2200mg/L peracetic acid
	SDS 0.65%, Chelating agents 7.9%	
Chlorclean tablet	sodium dichloroisocyanurate >30%	1000mg/L chlorine
	sodium toluenesulfonate 5-10%	
	adipic acid <12%	
Oxivir Tb	0.5% (5000mg/L) Accelerated@	5000mg/L hydrogen peroxide
Ready to use solution	hydrogen peroxide + surfactants	
Generic equivalents		
Proxitane solution	Hydrogen peroxide 27%	10080mg/L hydrogen peroxide
	Acetic acid 7.5%, Peracetic acid 5%	2200mg/L peracetic acid
20g SDIC tablets	Sodium diisocyanurate	1000mg/L chlorine
6% hydrogen peroxide	6% hydrogen peroxide (H_2O_2)	6000mg/L hydrogen peroxide

- Biofilms (n=5/test treatment) were treated for 5 minutes, disinfectant activity was neutralised with 1 ml of neutraliser containing 1% sodium thiosulphate, 6% Tween 80, 5% Bovine Calf Serum (BCS) and 10% Bovine Serum Albumin (BSA) in Phosphate Buffered Saline (PBS). Residual biofilm viability and mass were determined by plate culture and protein assay respectively (Figure 1).
- Disinfectant efficacy was tested before and after treatment with neutral detergent for 30 seconds and in the presence or absence of standardised soil (5% BCS and 10% BSA in PBS).

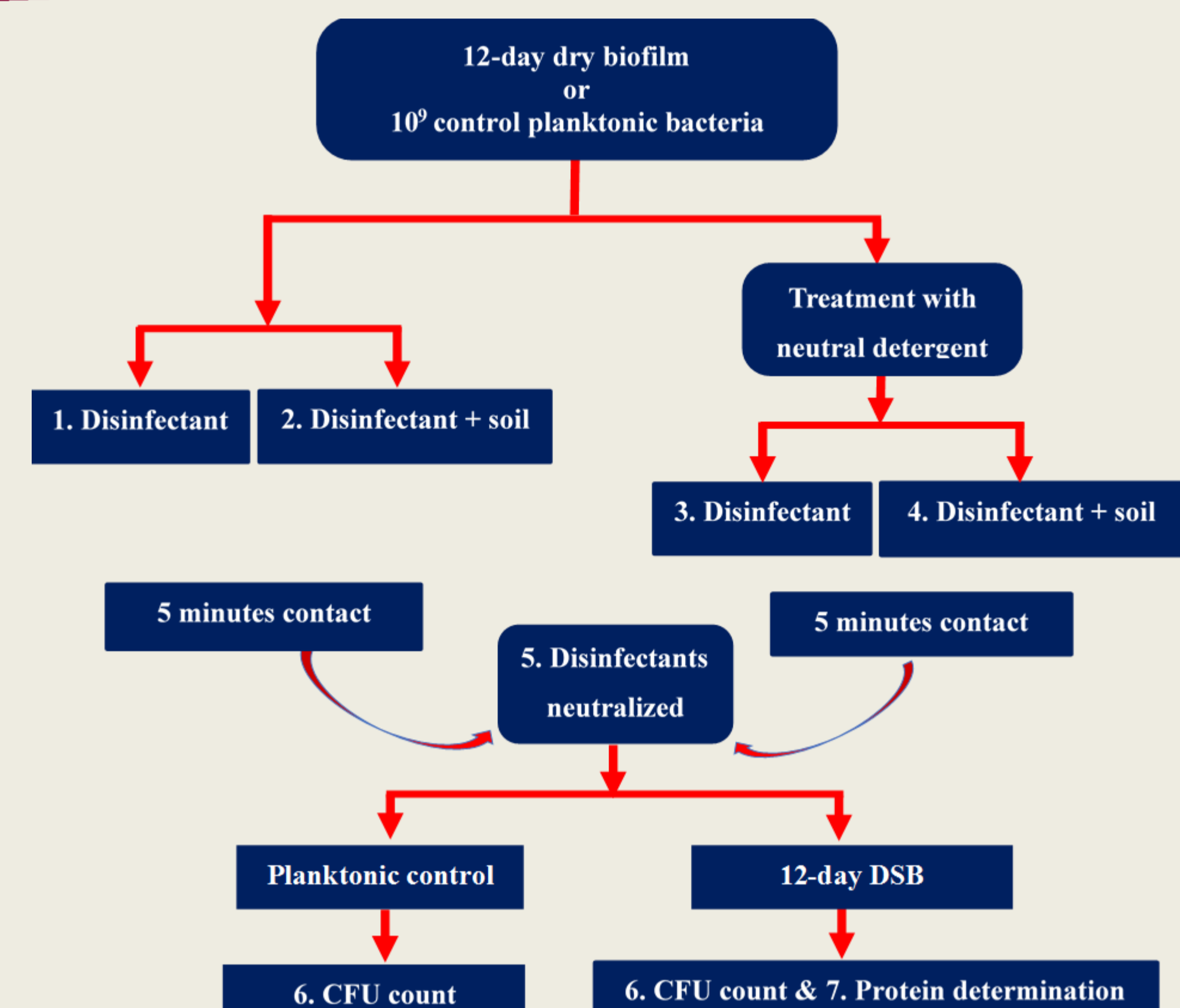


Figure 1: Experimental protocol for disinfection testing

RESULTS

- Formulated peracetic acid/hydrogen peroxide (Surfex) and hydrogen peroxide disinfectants (Oxivir) were significantly better than generic products suggesting additives act synergistically (Figure 2).
- In the presence of soil, the formulated peracetic acid/hydrogen peroxide (Surfex) completely inactivated biofilm ($6.3 \log_{10}$ reduction in titre) whilst the generic (Proxitane) failed to kill the DSB.
- The efficacy of the formulated and generic chlorine-based disinfectants was similar and reduced biofilm viability by $2.8 \log_{10}$ without soil but failed to kill biofilm in the presence of soil.
- Hydrogen peroxide disinfectants had little effect against DSB.

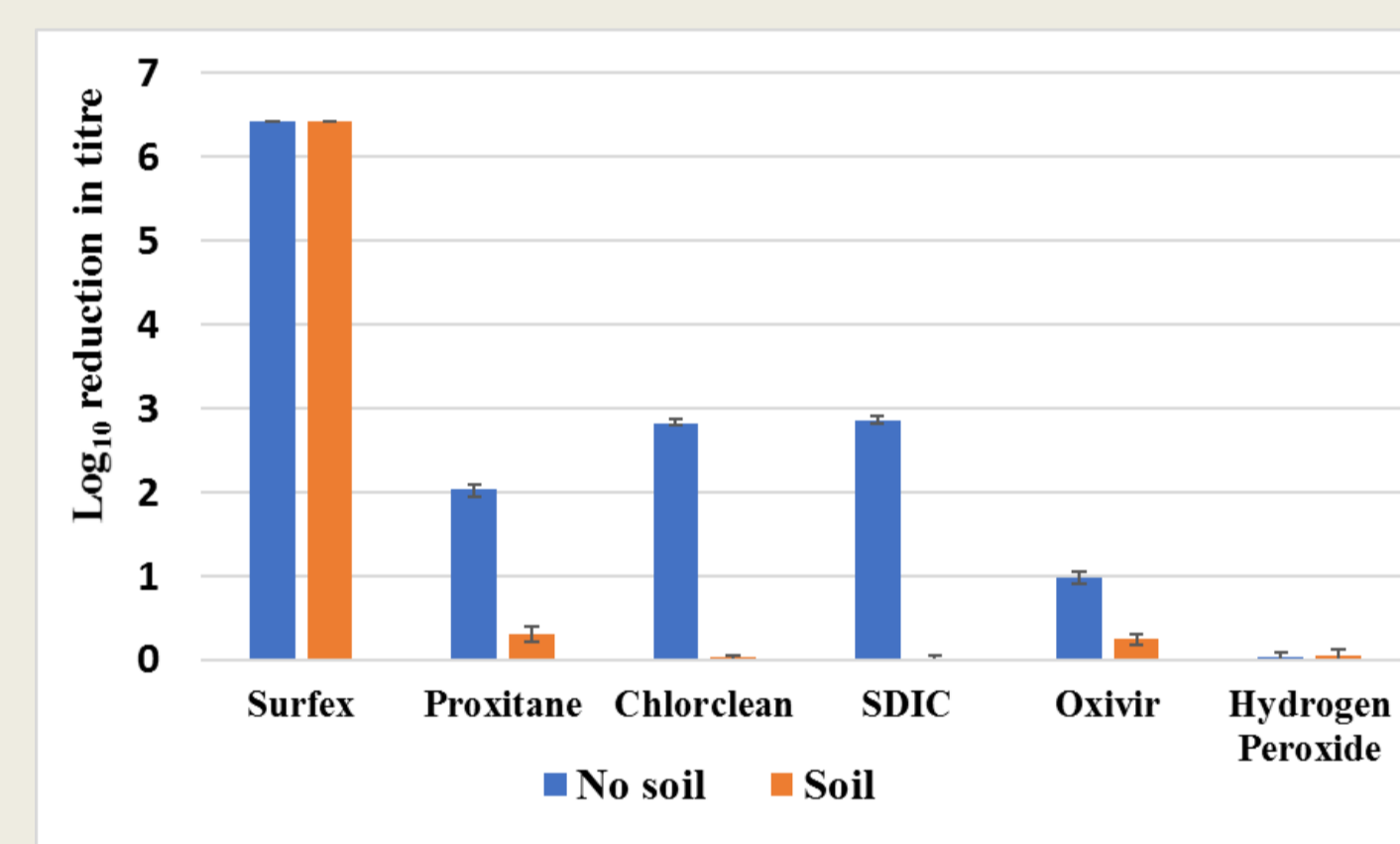


Figure 2. Log_{10} reduction in biofilm titre following 5 min contact with disinfectants.

- Detergent treatment had no effect on disinfectant efficacy under static conditions (Figure 3). Biofilm protein removal followed the same trend as kill (Figure 4).

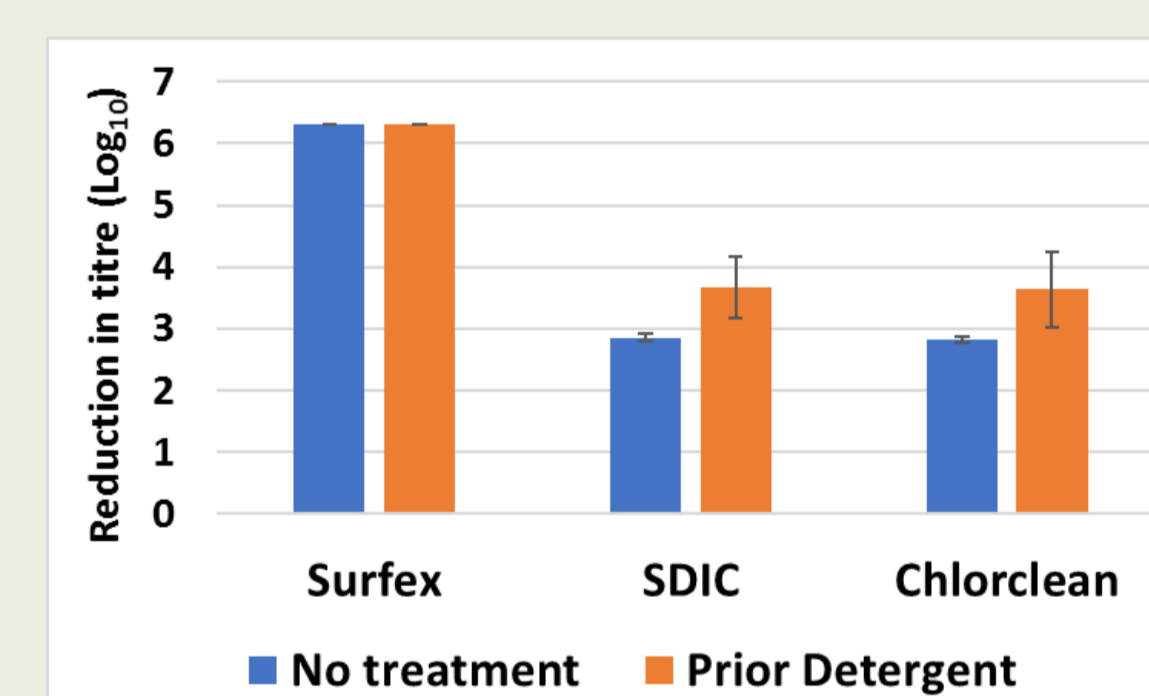


Figure 3: Reduction in DSB titre (Log_{10}) after detergent treatment followed by disinfection in the absence and presence of biological soil.

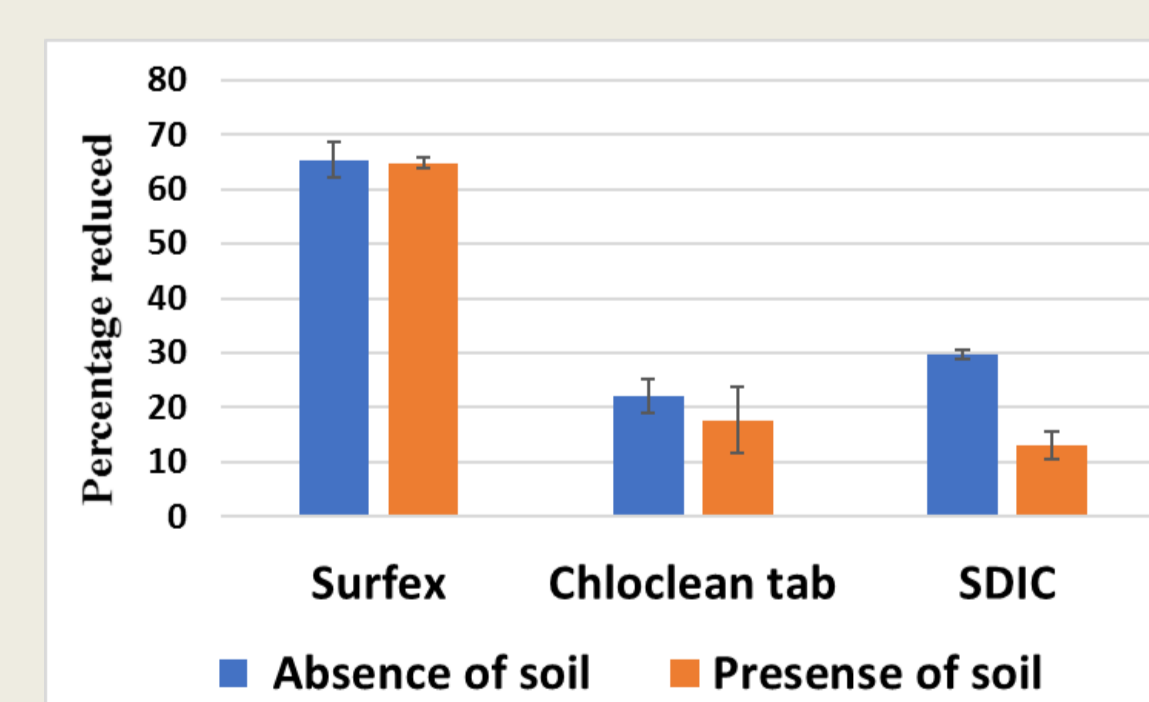


Figure 4: Percentage reduction of biofilm mass (protein) after disinfection with Surfex, Chlorclean tablet and SDIC for five minutes in the presence and absence of soil.

CONCLUSION

- The additives in fully formulated disinfectants can act synergistically with active ingredients and thus increase biofilm killing whilst decreasing the adverse effect of soil.
- We suggest that purchasing officers seek efficacy testing results from manufacturers and consider whether efficacy testing has been conducted in the presence of biological soil and/or biofilm.

REFERENCES

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