Resin Salve From Norway Spruce: Novel Therapy To Eradicate Bacterial Biofilms From Acute And Chronic Wounds

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Background: Resin is a hydrocarbon secretion of coniferous trees that protects plants against a broad range of invasive pathogens, such as bacteria, fungi, protozoans, archaea, and parasites. A 10% salve prepared from the resin of Norway spruce (*Picea abies*) is a promising treatment option in infected and non-infected acute and chronic wounds in a clinically relevant setting. On the basis of our clinical empirical observations, we hypothesized that the resin salve may inhibit the formation of microbial biofilms and eradicate existing biofilm.

Methods: The inhibitory and eradication capacity of Abilar 10% Resin Salve, Abilar 5% Resin Ointment (Repolar Pharmaceuticals Ltd., Espoo, Finland), Flamigel, and Flaminal Forte (Flen Pharma S.A., Kontich, Belgium) against biofilm formation by methicillin resistant *Staphylococcus aureus* (strain Mu50) and *Staphylococcus epidermidis* (strain ET013) were studied *in vitro* using the method described by Brackman et al. (J Appl Microbiol 2013, 114, 1833-42). The model system used in this study mimics the conditions found in a wound *in vivo*. Gauzes without wound care product (no treatment) served as negative controls.

Results: Significant inhibition of biofilm formation was observed when Abilar 10% Resin Salve, Abilar 5% Ointment, and Flamigel were tested against *S. epidermidis* (ET013). In addition, Abilar 5% Ointment and Flamigel significantly inhibited *S. aureus* (Mu50) biofilm formation (Figures 1 and 2). Similar activity was observed when investigating biofilm eradication.

Conclusion: Resin-based Abilar 10% salve and Abilar 5% ointment have *in vitro* inhibitory and eradicating activities against *S. aureus* and *S. epidermidis* biofilm. In addition, under some conditions the resin ointment was as effective as Flamigel.

FIGURE 1. Biofilm inhibitory effect of wound care products

Products	*S. aureus* Mu50				*S. epidermidis* ET013			
	CFU/disk		Log CFU/disk		CFU/disk		Log CFU/disk	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
CTRL	2.07E+08	2.05E+07	8.32	0.04	1.86E+08	5.98E+06	8.27	0.01
Flamigel	1.05E+07*	5.03E+06	7.02*	0.21	1.68E+06*	3.64E+05	6.22*	0.09
Flaminal Forte	1.33E+08	9.41E+07	8.12	0.31	1.84E+08	2.24E+07	8.26	0.05
Abilar 10% Resin Salve	1.53E+08	1.48E+08	8.18	0.42	6.32E+07*	4.04E+07	7.80*	0.28
Abilar 5% Ointment	7.75E+06*	1.12E+07	6.89*	0.63	1.14E+07*	3.19E+06	7.06*	0.12

Data are shown as mean (log) Colony Forming Units (CFU) / disk ± standard deviation (S.D.)

***products resulted in a significant ($p<0.01$) reduction in biofilm formation compared to the untreated control**

#products resulted in a significant ($p<0.05$) reduction in biofilm formation compared to the untreated control

FIGURE 2. Biofilm eradicating effect of wound care products

Products	*S. aureus* Mu50				*S. epidermidis* ET013			
	CFU/disk		Log CFU/disk		CFU/disk		Log CFU/disk	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
CTRL	2.03E+08	5.64E+07	8.31	0.12	2.16E+08	6.04E+07	8.33	0.12
Flamigel	2.76E+07#	1.62E+07	7.44#	0.25	4.71E+06*	5.47E+06	6.67*	0.50
Flaminal Forte	1.81E+08	1.35E+08	8.26	0.32	1.68E+08	4.66E+07	8.23	0.12
Abilar 10% Resin Salve	1.43E+08	1.33E+08	8.16	0.40	5.77E+07*	3.05E+07	7.76*	0.23
Abilar 5% Ointment	1.86E+07#	3.17E+06	7.27#	0.07	1.44E+07*	3.58E+06	7.16*	0.11

Data are shown as mean (log) Colony Forming Units (CFU) / disk ± standard deviation (S.D.)

***products resulted in a significant ($p<0.01$) reduction in biofilm compared to the untreated control**

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