SUMMARY REPORT

Antibacterial activity of Marmoleum flooring against bacteria causing hospital infections

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FOREWORD

I was invited to test Forbo's Marmoleum flooring for antibacterial activity as I had heard much about its bacteria fighting qualities. I have to admit, along with most of the scientific world, to having a degree of scepticism about these proclaimed qualities. I am now delighted to say that, after robust testing, the claims are shown to be quite true… Marmoleum does indeed inhibit the growth of several bacteria including MRSA.

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INTRODUCTION

Traditionally, Forbo's Marmoleum flooring has been used in hospitals and healthcare environments throughout the world due to its outstanding performance characteristics, natural raw materials and its exceptional hygiene properties.

Testing over several years repeatedly demonstrated the bacteriostatic activity of Marmoleum in relation to MRSA (*Methicillin-Resistant Staphyloccus aureus)* and other bacteria associated with hospital-acquired infection.

To build on these positive test results, further research in 2006 by TNO repeated and expanded the scope of this testing, including testing under 'worst case conditions' to prove conclusively the health properties of Marmoleum flooring.

The results of these extensive scientific tests are impressive and are summarized in this document. These results provide the most robust case for Marmoleum as an ally in the fight against infection.

METHODOLOGY

Laboratory studies sought to determine the nature of the antibacterial activity displayed by Marmoleum. Earlier qualitative tests showed the flooring was bacteriostatic (i.e. inhibited growth) in an agar diffusion assay using both *Staphyloccus aureus* and *Escherichia coli* as test organisms.

In the latest studies different batches of Marmoleum flooring were investigated (some manufactured more than 20 years ago) in terms of their antibacterial activity against a range of hospital pathogens. For *Staphyloccus aureus* and *Enterococcus sp*. there was consistent expression of antibacterial activity in all samples. For *Escherichia coli, Acinetobacter baumanni* and *Pseudomonas aeruginosa* expression of antibacterial activity was variable with some batches more active than others.

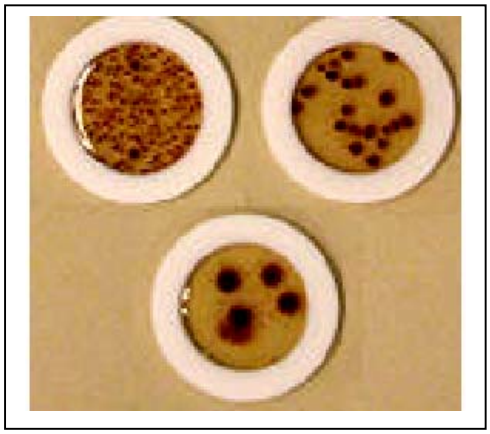
For *Staphyloccus aureus* the expression of inhibitory activity for Marmoleum was most marked when the flooring was exposed to higher than average levels of bacteria (up to 1 million bacteria). Visible colonies (to the naked eye) were not produced under these conditions with either a standard strain of *Staphyloccus aureus* or with isolates of epidemic MRSA found in Scotland (EMRSA 15 and EMRSA 16). With greater bacterial numbers pinpoint colonies were observed using a stereo-microscope. (see figure 1)

Marmoleum was also exposed to nutrient broth inoculated with *Staphyloccus aureus,* which resulted in significant inhibition of bacterial growth with either low numbers (1000) or higher numbers (100,000) for up to 6 hours (test period). Even after 24 hours there was a measurable reduction in bacterial growth. It should be noted that these conditions favour the growth of the bacterium because of the presence of nutrient. Repetition of the experiments in a less nutrient medium or in water, showed that the presence of Marmoleum reduced the viability of *Staphyloccus aureus* within 24 hours. There was at least a 99% drop in bacterial viability by 24 hours in diluted brain heart infusion broth (see figure 2) and a similar reduction by 16 hours in water (see figure 3). In both cases staphylococci retained their viability in the absence of Marmoleum.

RESULTS

Inhibition is present even at very high concentrations of bacteria (100 million per ml)

Growth of *Staphyloccus aureus* on reference material



Inhibition of *Staphyloccus aureus* on Marmoleum flooring

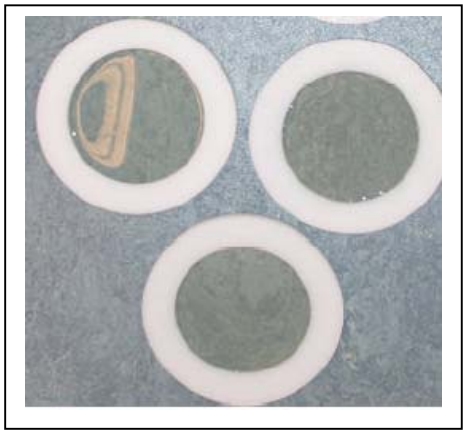


Figure 1 Inhibitory activity of Forbo flooring against *Staphyloccus aureus* as determined with the TNO agar layer test with different inoculation levels

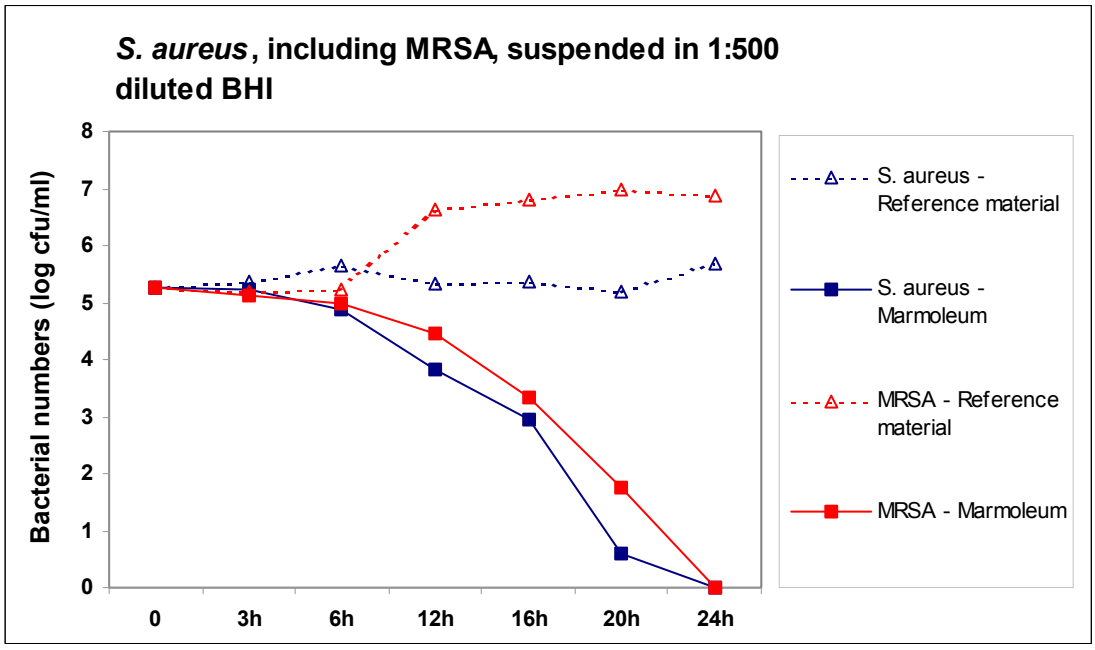


Figure 2: Inhibitory effect of Marmoleum on Staphyloccus aureus suspended in 1:500 diluted BHI during 24 h exposure time at 30°C

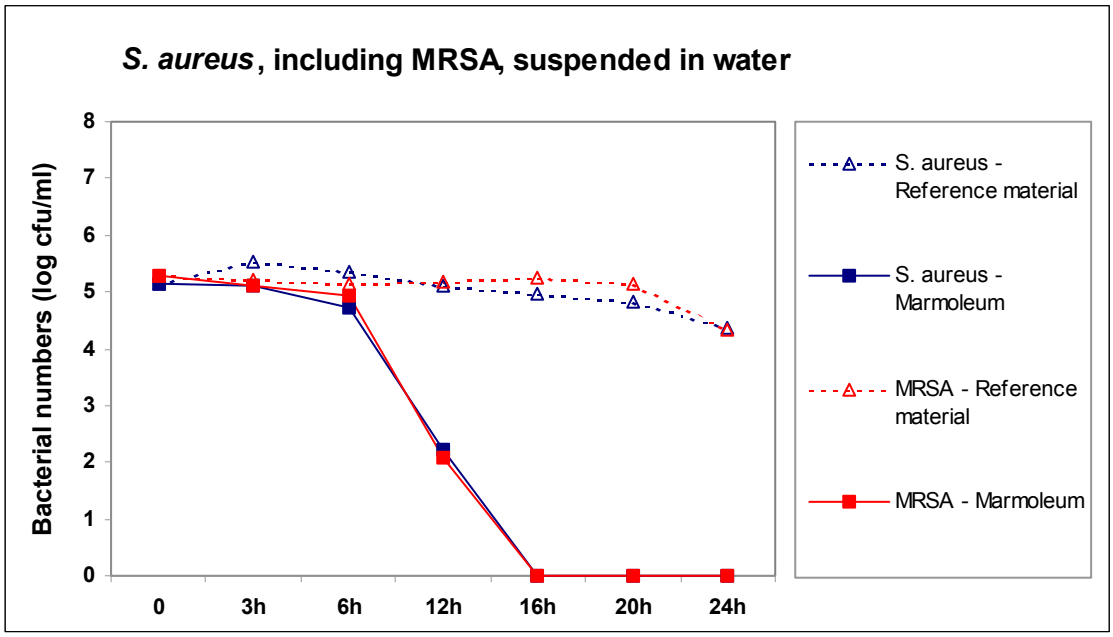


Figure 3: Inhibitory effect of Forbo flooring on Staphyloccus aureus suspended in water during 24 h exposure time at 30°C

Overall these results show that Marmoleum displays antibacterial activity which under some circumstances (nutrient rich) is bacteriostatic and other circumstances (nutrient deplete) is bactericidal. Methicillin-resistant strains of *Staphylococcus aureus* are as susceptible to inhibition by Marmoleum as is an antibiotic susceptible strain.

CONCLUSION

The aim of recent studies study was to prove conclusively that Forbo's Marmoleum inhibits the growth of MRSA and other hospital pathogens.

The tests have proven that Marmoleum not only inhibits the growth of MRSA, but excepting the most extreme laboratory testing conditions, MRSA actually loses viability in its presence i.e. MRSA is killed.

The antibacterial activity of Marmoleum flooring means that *Staphylococcus aureus* (including MRSA strains commonly associated with hospital acquired infections) is less likely to survive, thereby reducing the risk of spread.

These latest test results support Marmoleum's use as a recommended flooring product to be used in hospitals in the fight against infection.