



Control of Athlete's Foot Fungus by Articles Treated with the ÆGIS Microbe Shield®

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Abstract

Athlete's foot is caused by microorganisms isolated in dark moist areas of the feet. Shoes and socks in direct contact with these areas are potential harbors of refuge for the attacking organisms. The ÆGIS Microbe Shield® Program provides antimicrobial protection from the growth of fungi and bacteria on these treated articles. This report documents the laboratory data that demonstrates the effectiveness of the durably bound antimicrobial against the specific organism involved in athlete's foot infection.

Introduction

Athlete's foot is a common skin infection in which most people will develop over the course of their lives. The medical term, *tinea pedis*, indicates a fungal infection of the feet and is seen as itchy, scaly, toe-web lesions to which athletic young adults are most prone. In the UK this past year, 17% of all adults indicated some form of athlete's foot infection. Athlete's foot is the result of the infection of the fungi *Trichopyton rubrum* and *Trichopyton mentagrophytes*. These fungal organisms colonate the dark and moist area between the toes. It is the moisture, sweating and lack of ventilation that provides the perfect environment for the fungus of Athletes foot to grow. Later and more severe cases of Athletes foot are the result of bacterial infections which colonate due to the stressed environment brought on by the fungal infection. The more severe infections result in redness, swelling, and are accompanied by foul foot odors.

In general, antifungal creams can prevent and cure the fungal infection of athlete's foot. If the more severe case of the infection is found, antibacterial agents are also needed. Daily practices are responsible for the infections of Athletes foot infections. Routine cleaning and thorough drying of the feet in a addition to the use of clean shoes and socks treated with a durable, broad spectrum antimicrobial agent will decrease the likelihood of infection.

The active ingredient found in the ÆGIS Microbe Shield antimicrobial product has been demonstrated for the past 30 years to be effective against a broad spectrum of microbial organisms. From bacteria, fungi, yeast, and algae, the ÆGIS antimicrobial agent physically and ionically kills the microorganism on contact. The presence of the ÆGIS microbe shield in the shoes and socks will significantly reduce the local concentration of organisms that contribute to the athlete's foot infection.

Demonstrated durability will provide long lasting protection upon multiple washes.

Results and discussions

ÆGIS Environments and the Dow Corning Corporation have studied the effectiveness of the ÆGIS Microbe Shield product against the specific organism responsible for Athlete's foot. The treated and untreated sock fabrics consisted of Orlon/nylon, nylon, cotton/nylon, and commercially treated socks purchased from a major retailer, London. Each set of samples was tested using the test organism, *Trichopyton mentagrophytes*, using the industry standard antimicrobial test method, AATCC100. Lethen broth has been shown in the historical data base for AEM 5772 and other quats to be effective as a neutralize in a test system and was used in this system.

The fungal counts from the treated and untreated sock fabrics are presented in Table I (Nylon), Table II (Orlon/nylon), Table III (Cotton/nylon), and Table IV ("Fresh Feet"). The treated sock fabrics were capable of reducing significant levels of athlete's foot fungus, as compared to the untreated sock fabrics, through 10 laundering cycles. The activity diminished slowly after 10 launderings using this test method to determine efficacy. A 99.9% reduction or 3 log decrease in fungal CFU count on the treated test fabric versus the untreated control fabric indicates excellent activity against the test organism.

The antifungal activity of a commercially prepared sock sample was also tested for the activity against the athlete's foot fungus. The full antimicrobial activity was demonstrated using the industry standard test method ASTM E2149-01. These results are presented in Table IV. In this test method, fungal cultures are grown and before testing, conidia are separated from the Mycelia fragments. The resulting solution is used as the standard inoculum for the Dynamic portion of the test method. After 1 hour of agitation, the cells are re-isolated, grown in the incubator and counted. As an additional measure of control, the cells isolated after the test were further analyzed to ensure that they were the proper test organism. Each isolated organism re-grew the fungal Mycelia associated with *Trichopyton mentagrophytes*.

Athlete's foot infection is the result of the growth of the fungal organism *Trichopyton*. More severe infections occur after the fungi have conditioned the environment for

further growth. The secondary bacterial infections are much more severe than the original fungal infection. The organisms are typical skin type bacteria and include Gram + bacteria, *Staphylococcus aureus*, and Gram - bacteria, *Proteus* and *Pseudomonas*. Many antimicrobial agents are specific against either Fungi, Gram + or Gram - bacteria but usually are not effective against all these organisms. The ÆGIS antimicrobial agent acts by specifically rupturing the cell membrane of these organisms and has been shown to be fully effective

against fungi, bacteria and algae. Table V contains data using the ASTM E2149-01 antimicrobial test method demonstrating the antibacterial activity against the bacteria responsible for secondary and more severe forms of Athletes foot infection. For each bacteria tested, the commercially sold sock demonstrated excellent activity with over 99.9% bacterial reduction within the 1 hour of contact time.

Tables:

#	Description Antimicrobial Fabrics	Microbiological Analysis		Pass/Fail*
		Fungal CFU/sample 18 hours	Fungal (% Reduction) Versus untreated control	
1	Untreated	9.7×10^5	0	Fail
2	Treated	$< 10^2$	99.99	Pass
3	Untreated 5 wash	1.01×10^6	0	Fail
4	Treated 5 wash	$< 10^2$	99.9	Pass
5	Untreated 10 wash	9.0×10^5	0	Fail
6	Treated 10 wash	3.15×10^2	99.97	Pass
7	Untreated 20 wash	8.6×10^5	0	Fail
8	Treated 20 wash	2.13×10^4	97.52	Pass
9	Untreated 25 wash	9.5×10^5	0	Fail
10	Treated 25 wash	9.6×10^4	89.89	Pass

Table I. Antifungal activity of treated Nylon fabrics against *Trichophyton mentagrophytes*.
Test Fungus: *Trichophyton mentagrophytes* ATCC 9533. Test methods AATCC 100 antimicrobial

#	Description Antimicrobial Fabrics	Microbiological Analysis		Pass/Fail*
		Fungal CFU/sample 18 hours	Fungal (% Reduction) Versus untreated control	
1	Untreated	2.91×10^6	0	Fail
2	Treated	$< 10^2$	99.99	Pass
3	Untreated 5 wash	2.03×10^6	0	Fail
4	Treated 5 wash	1.11×10^2	99.9	Pass
5	Untreated 10 wash	1.98×10^6	0	Fail
6	Treated 10 wash	1.27×10^3	99.94	Pass
7	Untreated 20 wash	2.20×10^6	0	Fail
8	Treated 20 wash	2.13×10^4	99.03	Pass
9	Untreated 25 wash	2.83×10^6	0	Fail
10	Treated 25 wash	1.93×10^5	93.18	Pass

Table II. Antifungal activity of treated Orlon/Nylon fabrics against *Trichophyton mentagrophytes*.
Test Fungus: *Trichophyton mentagrophytes* ATCC 9533. Test methods AATCC 100

#	Description Antimicrobial Fabrics	Microbiological Analysis		Pass/Fail*
		Fungal CFU/sample 18 hours	Fungal (% Reduction) Versus untreated control	
1	Untreated	1.89 x 10 ⁶	0	Fail
2	Treated	< 10 ²	99.99	Pass
3	Untreated 5 wash	2.36 x 10 ⁶	0	Fail
4	Treated 5 wash	1.44 x 10 ²	99.9	Pass
5	Untreated 10 wash	2.79 x 10 ⁶	0	Fail
6	Treated 10 wash	2.33 x 10 ³	99.95	Pass
7	Untreated 20 wash	2.41 x 10 ⁶	0	Fail
8	Treated 20 wash	2.11 x 10 ⁴	99.0	Pass
9	Untreated 25 wash	1.01 x 10 ⁷	0	Fail
10	Treated 25 wash	1.99 x 10 ⁵	90.4	Pass

Table 111. Antifungal activity of treated Cotton/Nylon fabrics against Trichophyton mentagrophytes.
Test Fungus: Trichophyton mentagrophytes ATCC9533. Test method: AATCC 100

#	Description Antimicrobial Fabrics	Microbiological Analysis		Pass/Fail*
		Fungal CFU/sample 1 hour	Fungal (% Reduction) Versus untreated control	
1	Untreated	9.7 x 10 ⁵	0	Fail
2	Treated	< 10 ²	99.99	Pass

Table IV. Antifungal activity of treated Marks & Spencer “Fresh Feet” socks against Trichophyton mentagrophytes.
Test Fungus: Trichophyton mentagrophytes ATCC 9533. Test method: ASTM E2149-01



#	Description Antimicrobial Fabrics	Microbiological Analysis		Pass/Fail*
		Fungal CFU/sample 1 hour	Bacterial (% Reduction) Versus untreated control	
<i>Escherichia coli</i>				
1	Untreated	1.2×10^5	0	Fail
2	Treated	$< 10^2$	99.99	Pass
<i>Proteus mirabilis</i>				
3	Untreated	5.2×10^5	0	Fail
4	Treated	$< 10^2$	99.99	Pass
<i>Staphylococcus aureus</i>				
5	Untreated	1.5×10^5	0	Fail
6	Treated	$< 10^2$	99.99	Pass
<i>Pseudomonas aeruginosa</i>				
7	Untreated	1.8×10^5	0	Fail
8	Treated	$< 10^2$	99.99	Pass
<i>Serratia marcescens</i>				
9	Untreated	1.9×10^5	0	Fail
10	Treated	$< 10^2$	99.99	Pass

Table V. Antibacterial activity of treated Marks & Spencer “Fresh Feet” socks against common skin and soil bacteria.
Test method: ASTM E2149-01



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