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RESEARCH ARTICLE

DECONTAMINATION OF SHOE SOLES COLONIZED BY *TRICHOPHYTON RUBRUM*: EFFECT OF TERBINAFINE 1%

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Abstract

Introduction: Moisture, heat and maceration in shoes are factors that allow the survival of dermatophytes and the recurrence of foot dermatophytosis, especially onychomycosis. The aim of our study was to assess, in real-life situation, the efficacy of terbinafine 1% on shoe soles colonized by skin scales infected by *T. Rubrum*.

Study design: Four types of commercial shoe soles were tested: synthetic, silicone, wool and leather. Three samples of each type were tested: one untreated as a control, and the other two treated with terbinafine 1% (spray solution and cream). Samples of skin scales were taken from patients with *T. Rubrum* dermatophytosis proven by mycological examination (direct examination and culture).

Results: *T. Rubrum* colonies grew on all cultures from control insoles. Whereas the cultures from skin scales treated with terbinafine 1% (solution or spray) were all sterile after three weeks and remained sterile after at six weeks.

Conclusion: This study confirms the efficacy of terbinafine 1% (solution or cream) for the decontamination of insoles infected by *T. Rubrum*. A single application can sterilize the insoles in 48h.

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Introduction:-

Dermatophytes are filamentous fungi that invade the keratinized tissues, causing one of the most common infections in the medicine. These pathogens will spread through two ways: direct contact with other people, animals, and soil; or indirectly from fomites [1]. Shoes worn with bare feet are a fungal reservoir and cause recurrence of foot dermatophytosis, especially onychomycosis. Moisture, heat and maceration are factors that maintain the ability of dermatophytes to survive up to 10 years in skin scales [2]. The dermatophyte *Trichophyton Rubrum* is the major cause (90%) of tinea pedis and onychomycosis [3]. Terbinafine is an antifungal agent which has known efficacy against dermatophytes. In addition, spontaneous *T. Rubrum* mutants resistant to terbinafine are very rare and prolonged exposure of the organism to terbinafine does not lead to significant loss of susceptibility [4]. In addition of its efficacy, terbinafine has been shown to be a noncorrosive and a non-toxic disinfectant against dermatophytes [5].

The aim of our study was to assess, in real-life situation, the efficacy of terbinafine 1% (spray solution and cream) on shoe soles colonized by skin scales infected by *T. Rubrum*.

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Study design:

Four types of insoles with different composition were tested: synthetic, silicone, wool and leather. For each type of insole, three samples were used: one served as a control and was not treated with Terbinafine; one insole was treated with terbinafine 1% spray solution, and one with terbinafine 1% cream.

Each sample was placed in a closed and sterile Petri dish, at ambient temperature (Figure 1). Skin scales infected with *T. Rubrum* were dispersed on the different insoles. These scales were samples taken at our laboratory from patients with *T. Rubrum* dermatophytosis proven by mycological examination (direct examination and culture). They were moistened with a sterile saline solution to prevent the desiccation of the scales and to mimic the actual foot sweating conditions. After 48 h of humidification, the experimental insoles were treated with a single spray of terbinafine 1% spray solution and with one application of the cream. The control insoles were left untreated. After 48 hours of contact with terbinafine, all the skin scales dispersed on the soles were collected separately for each sample, by scraping them off. Two types of tubes were used for the culture of these scales: tubes of Sabouraud agar with chloramphenicol and cycloheximide, and tubes of Sabouraud agar with chloramphenicol without cycloheximide. All the tubes were placed in an incubator at 25 °C. The cultures were examined after 3 and 6 weeks.

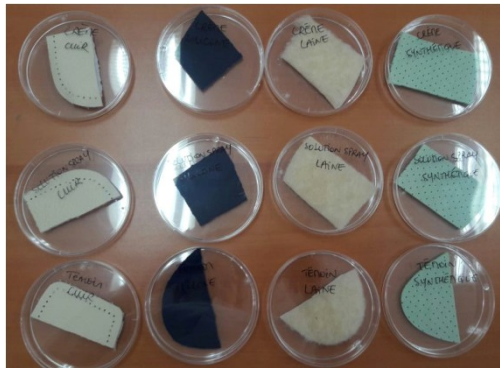


Figure 1:- Insoles sample in closed and sterile Petri dish, at ambient temperature.

Results:-

T. Rubrum colonies grew on all untreated cultures from control insoles (Figure 2). Whereas the dermatophytes could no longer be cultured after the application of terbinafine, irrespective of the type of insole colonized. Indeed, the cultures from skin scales treated with terbinafine 1% (formulated either as a spray solution or cream) were all sterile after three weeks and remained sterile after at six weeks (Figures 3 and 4).

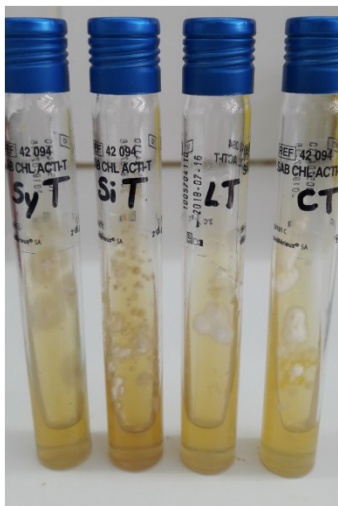


Figure 2:- Culture results of untreated skin scales used to infect the shoe soles. Control Tubes of Sabouraud agar with Chloramphenicol- cycloheximide. SyT: Synthetic Control, SiT: Silicone Control, LT: Wool Control, CT: Leather Control.

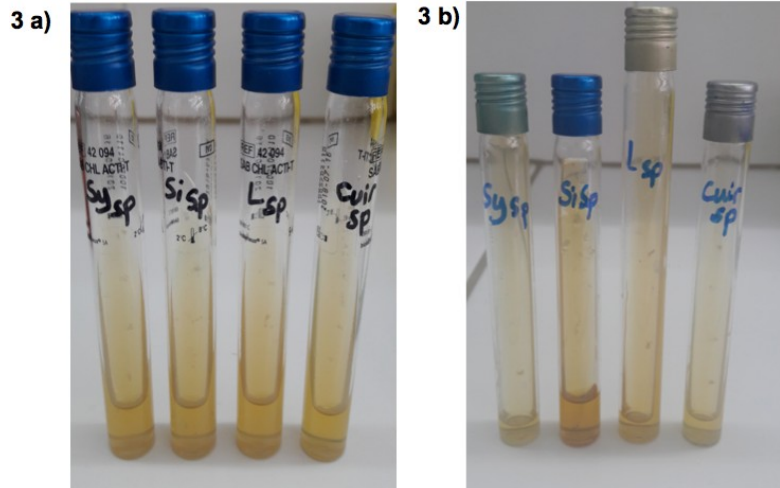


Figure 3:- Culture results of skin scales treated with Terbinafine 1% Spray. **a)** Tubes of Sabouraud agar with chloramphenicol-cycloheximide. **b)** Tubes of Sabouraud agar with chloramphenicol. SySp: Synthetic Spray, SiSp: Silicone Spray, LSp: Wool Spray, CuirSp: Leather Spray.

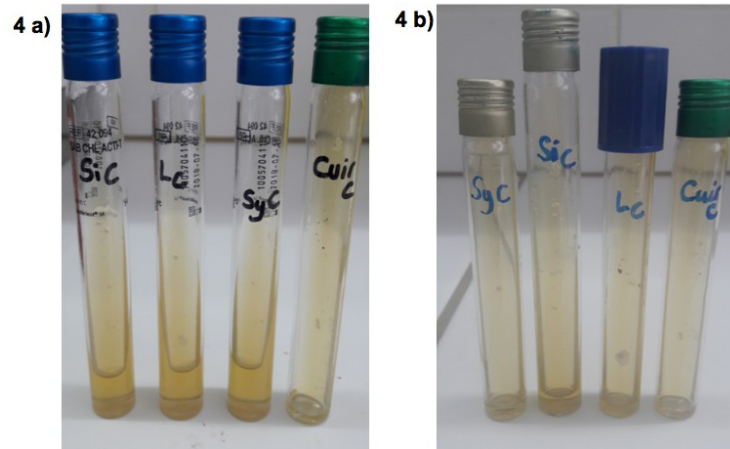


Figure 4:- Culture results of skin scales treated with Terbinafine 1% Cream. **a)** Tubes of Sabouraud agar with chloramphenicol- cycloheximide. **b)** Tubes of Sabouraud agar with chloramphenicol. SyC: Synthetic Cream, SiC: Silicone Cream, LC: Wool Cream, CuirC: Leather Cream.

Discussion:-

The results of this real-life study confirm that treatment of shoe soles colonized with skin scales infected by *T. Rubrum* is possible. A study conducted by M. Feuilhade de Chauvin has demonstrated the efficacy of Terbinafine on shoes colonized by skin scales infected with *T. Rubrum*. In this study, Terbinafine was formulated as 1% spray solution and 1% spray powder, and tested on three types of insoles : foam rubber, 'carbon active' latex and leather insoles [6]. Our study showed the same results, using different conditions from the formal study: Terbinafine 1% was formulated as spray solution and cream, and four types of insoles were tested: synthetic, silicone, wool and leather.

A study showed that the topical spray and the topical solution have comparable anti-fungal activity. They are equally effective in the treatment of tinea pedis and remove the risk of organism transfer associated with touching infected areas [7]. Therefore they can both be used to decontaminate shoes soles.

Furthermore, all contaminated textile surfaces should be treated to avoid recurrence of dermatophytosis. Morello and al showed that commercial ready-to-use disinfectants labelled as fungicidal were as fungicidal as 1:10 sodium hypochlorite. Therefore they can be used on textile surfaces to kill infective material not removed during the

mechanical removal of debris and gross cleaning steps [8].

Other than the decontamination of insoles, several recommendations on prevention of onychomycosis has been published. They focus on removing the soles from shoes to air them out, avoiding walking barefoot in public places (swimming pools, sports halls...), washing and drying feet, disinfecting bathtubs, using leather shoes rather than shoes with soles of synthetic material and showering every day [9]. The use of topical antifungal medications as prophylactic treatment helps prevent recurrence of toenail onychomycosis and suggests that those with a family history of fungal infections should be closely monitored [10], and for that purpose, Terbinafine was found to be the most effective antifungal drug against dermatophyte isolates tested in a turkish study, including *T. Rubrum* [11].

Conclusion:-

This study confirms the efficacy of terbinafine 1%, formulated either as a spray solution or cream, for the decontamination of shoe soles colonized by skin scales infected by *T. Rubrum*. A single application can sterilize shoe soles of all kinds (synthetic, silicone, wool or leather) in 48 hours. The decontamination of shoes is therefore necessary to eradicate recontamination and prevent recurrences and relapses in the treatment of tinea pedis and dermatophyte onychomycosis.

Statement of interests:

The authors report no conflict of interest.

Competing interests:

None declared.

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