ANTIMICROBIAL COMPOSITION FOR THE PROTECTION OF LEATHER, FURS AND LEATHER ARTICLES

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This work presents a composition based on essential oils for the protection of leather, furs and leather articles against fungi. The composition based on essential oils, such as: thyme oil, cinnamon oil, cloves oil, oregano oil, lavender oil in a proportion of 10 to 50% of the total composition. The composition was tested against *Trichophyton interdigitale* by applying by spraying of 5 -7 passes on the surface of sheepskins lining leather, furs or leather articles / shoes. The composition was effective 28 days for sheepskins lining leather and furs and 15 days for inside shoes, against *Trichophyton interdigitale*.

Keywords: essential oils, antifungal activity, lining leather, furs, shoes

INTRODUCTION

It is known that leather, fur and leather articles can be easily contaminated with various bacterial and fungal species (Chirila, 2014 a, b, c). These microorganisms can damage the material or be pathogenic to the wearer. Hides/skins and leather items are very sensitive to the destructive action of molds, while footwear linings may be contaminated with pathogenic bacteria or dermatophytes.

Among these microorganisms recall species: *Aspergillus niger*, *Aspergillus flavus*, *Trichoderma viridae*, *Penicillium glaucum*, *Penicillium cyclopium*, *Paecilomyces varioti*, *Candida albicans*, *Scopulariopsis brevicaulis* that develops on various leather items, degrading material.

Also, the warm and humid environment inside the shoe facilitates the development of various harmful microorganisms that can cause foot diseases. Pathogenic fungi that grow on the human skin include: *Trichophyton interdigitale*, *Trichophyton rubrum*, *Epidermophyton floccosum* and *Microsporum gypseum*, *Aspergillus niger*, *Aspergillus flavus*. These fungi cause *tinea pedis*, a condition known as “athlete's foot”. These fungi are located between the toes, feet or nails, causing onychomycosis. “Athlete's foot” is very contagious and can easily be transmitted through footwear previously worn by infected people, as spores remain on the material with which the footwear is lined. By the same mechanism, the “athlete's foot” can recur after it has been removed by treatment. Disease prevention is more effective than treating them. Therefore, a lining material for footwear lined with antifungal / antimicrobial properties could prevent both the spread of fungal infections and the reinfection of the wearer.

For the protection of leather, fur, footwear and leather articles against microorganisms biocides are used (Deselnicu, V. *et al.*, 2005; Deselnicu, V. *et al.*, 2007). Biocide act as oxidizing agents or by distorting or crosslinking proteins, through a number of mechanisms including inhibition of bacterial enzyme systems (Radwan *et al.*, 2014). Biocides are part of chemicals potentially harmful to humans and the environment, therefore their production and marketing is regulated and monitored continuously by European directives and regulations of European Parliament and Council (Deselnicu, D.C., 2014; Deselnicu, D.C. *et al.*, 2014). There is no EU legislation in regulating specifically the content of chemicals in footwear and other leather products, but the use of chemicals is restricted by REACH (EC 1907/2006).

Attempts to use essential oils to obtain disinfectant solutions based on essential oils are known (Deselnicu, V. *et al.*, 2016; Berechet *et al.* 2016 a, b; Chirila C. *et al.* 2016; Chirila C. *et al.*, 2017; Stevi *et al.*, 2014). However, due to their hydrophobic nature, essential oils are not readily miscible with water. As a result, essential oil is often difficult to incorporate into an aqueous solution.

Thus, U.S. Pat. no. 5,403,587 (McCue *et al.*, 1985) discloses an antimicrobial composition which uses both a solvent and a surfactant to facilitate the formation of a homogeneous aqueous mixture of essential oils. Although this disinfectant composition is more natural than others, it requires relatively high concentrations of solvent and synthetic surfactant, and its effectiveness is questioned.

U.S. Pat. 9,655,939 B2 (Reeve and Michael, 2017) describes an antifungic and/or antiviral composition effective against *Staphylococcus aureus* for application to the surface of any type of electrical device such as a computer, keyboard, mouse, television, MP3 player portable. The disadvantage of this composition is that it is used for non-porous surfaces and contains high concentrations of solvent.

WO Patent 2011156415 A2 (Barnhill, 2010) discloses a composition composed of three key elements: i) Ethyl alcohol (main component), ii) Essential oils (tea tree oil and peppermint oil) and iii) water which form a liquid sprayable mixture on susceptible surfaces of microbial infestation. The disadvantage of this invention is that it relates to the treatment of nonporous surfaces in hospitals, gymnasiums, hotels and care centers, which are sources of bacterial pathogens such as MRSA Staph aureus, non-MRSA Staph and Strept Group A that can survive for long periods of time.

Thus, there is a need for compositions and methods which are not limited to use on non-porous surfaces and which can be used on porous surfaces such as leather, furs, leather articles, shoes, etc..

This paper present a composition which relates to such a necessity, based on essential oils having synergistic antimicrobial properties, which can be applied on leather, furs, footwear, reducing /eliminating harmful microorganisms on the surfaces to which it is applied and ensuring that the color and dimensions of the surfaces on which it is applied are not modified.

MATERIALS AND METHODS

Materials

The antimicrobial composition contains essential oils in a total amount of about 10 to 50% of the total antimicrobial composition, as follows:

- Thyme Essential oil – the major compounds identified by gas chromatography were ca. of 57,35% and γ -terpinene approx. 32.43% (Berechet *et al.*, 2016a).
- Cinnamon Essential oil (*Cinnamomum aromaticum*) the major compounds identified was cinamaldehyde, ca. 84.12% (Berechet *et al.*, 2016b).
- Cloves Essential oil (*Eugenia caryophyllata*), the major compounds identified was eugenol with a 96.99% area (Berechet *et al.*, 2016b).
- Oregano Essential oil (*Origanum vulgare*) the major compounds identified were tymol, ca. 64.41% and carvacrol approx. 27.62% (Berechet *et al.*, 2016b).
- Lavender essential oil (*Lavandula angustifolia*) the major compounds identified were geraniol ca. 26,34%, camphor approx. 23.19% and eucalyptol ca. 20.82% (Berechet *et al.*, 2016b).

The antimicrobial composition contain a mixture of essential oils that are solubilized or dispersed in water with a solubilizing or dispersing agent. The antimicrobial composition contain one or more non-toxic organic solvents that help disperse the oils in water and increase the rate of evaporation after application to the treated surfaces. The resulting essential oil solution or dispersion is a homogeneous mixture that allows for easy and efficient application of the composition on the treated surface by spraying.

Sheepskins for footwear linings
Woolen sheepskins for footwear uppers
6 pairs of women shoes with leather uppers
Biologic material: Trichophyton interdigitale

Methods

Antifungal activity against Trichophyton interdigitale: The tests were made following standard ASTM D4576–86 (1996) - Standard Test Method for Mold Growth Resistance of Wet Blue. Petri dishes were placed in thermo-hygrostat at 30°C temperature and were analyzed after 3, 7, 14, 21 and 28 days.

Optical microscopy images were captured using a Leica stereomicroscope S8AP0 model with optic fiber cold light source, L2, with three levels of intensity, and magnification 40X.

Treating materials: Composition was applied by spraying 5-7 passes on the surface of lining leather, fur or inside shoes.

RESULTS AND DISCUSSION

Antifungal Activity

Antifungal activity of essential oil composition against *Trichophyton interdigitale* have been tested on sheepskin leather for footwear lining (Table 1), furs (Table 2) and footwear (Figure 1).

Table 1. Antifungal activity of essential oil composition against *Trichophyton interdigitale* on sheepskin leather for lining

	3 days	7 days	14 days	21 days	28 days
Essential oil composition
Grade	0	0	0	0	0
Control
Grade	2	4	4	4	4

Table 2. Antifungal activity of essential oil composition against *Trichophyton interdigitale* on furs

	3 days	7 days	14 days	21 days	28 days
Essential oil composition
Grade	0	0	0	0	0
Control
Grade	4	5	5	5	5

At antifungal activity testing, a total inhibition of the development of *Trichophyton interdigitale* was found for a period of 28 days on skins and fur treated with the antifungal composition, as compared to the untreated control sample, which showed growth of fungi after 3 days.

The antifungal activity of the composition against *Trichophyton interdigitale* was also tested on wearing footwear by treating the shoe interior in the fingers area (left shoe), having as control untreated shoe (right shoe) (Figure 1). After 30 days of wearing shoes, samples were taken from the inside of the shoes in the fingers area and the antifungal activity of the treatment with essential oils based composition was tested.

Figure 1. Antifungal activity of essential oil composition against *Trichophyton interdigitale* on the footwear: a) treated footwear and b) untreated footwear

Almost a total inhibition of fungi was observed through the treatment of the shoe interior. Untreated shoes were observed to have colonies of *Aspergillus flavus*, *Candida albicans*, *Penicillium* and *Trichophyton interdigitale* after 5 days (Figure 2).

Figure 2. Fungi growth after 5 days on the untreated shoes: a) *Aspergillus flavus*; b) *Aspergillus niger*; c) *Penicillium*; d) *Trichophyton interdigitale*

The antimicrobial composition based on the essential oils has the following advantages: it is biodegradable; not toxic for people's health; ecofriendly for the environment; non-corrosive, has neutral pH; does not change the color of the material on which it is applied and preserves the integrity / dimensions of the treated materials; it is based on raw materials from renewable resources; easy application by spraying, moistening.

CONCLUSION

The antimicrobial compositions due to the presence of several essential oils having synergistic antimicrobial properties, significantly reduce/eliminate the harmful microorganisms on the surfaces to which they apply. This composition it is an alternative method for the protection of leather, furs and leather articles.

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