COMBATING INVASIVE MOSQUITOES BY TEXTILES AND PAINTS

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ABSTRACT

Present paper discusses about mosquito repellents on textile and paints as one of attempt for protecting people against invasive mosquitoes which transmit arboviruses such as Zika, dengue and chikungunya virus, West Nile fever, Malaria, etc. For this purpose, the cotton fabric has been treated with selected repellents (Immortelle oil, Waterglass and Vibroactivated zeolites) for textiles and paints. For paints, Immortelle oil repellent was applied by coating special paper with paint layers between 80-160µm, and dry on the air. This paper will discuss the repellents efficacy, the changes of some textile structure parameters with fabric density, the amount of adsorbed repellents, by using gravimetric method, air permeability tester, pore dimensions Bubble Point measurements device and SEM image analyser.

Key Words: invasive mosquitoes, repellents, cotton fabric, paints

1. INTRODUCTION

Vector-borne diseases such as Malaria, Dengue, Chikungunya and Yellow fever, have spread from Asia and Latin America to other continents in last decades, mostly because of certain climatic conditions [1]. In 2018 a total number of 1. 317 cases of West Nile neuroinvasive disease (WNND) occurred in European countries (Italy 495, Greece 283, Romania 256, Hungary 197, Croatia 45, France 16, Austria 15, Bulgaria 6, Slovenia 3 and the Czech Republic 1). Certain countries near to Europe reported a total of 434 e cases (Serbia 350, Israel 81 and the Kosovo Region 3) accompained with relative high 149 deaths, mostly in Italy, Romania, Greece and Serbia [2]. Additionally, in recent years, dengue fever has also reached Europe. For the first time, in 2010 dengue was recorded in Croatia, France and Italy, in 2012 and 2013 in Portugal [2, 3]. These infections are transmitted mainly by *Aedes* aegypti, *Aedes albopictus, Culex sp and Anopheles sp, too*. These mosquitoes spread rapidly world-wide. One of the reasons for their territorial expansion is the global trade, travel tourism and global warming.

Present paper discusses the mosquito repellents efficacy on textile and paints as one of attempt for protecting people against invasive mosquitoes. These mosquitoes transmit arboviruses, such as Zika, dengue and chikungunya virus, West Nile fever, Malaria and others. In addition to this, the current flow of migrants from Africa and Asia to European countries has added the risk of spreading various diseases, including those mosquitoes are vectors. Knowledge about the spread of such rare diseases and measures to monitor their prevention is the foundation of the battle against these diseases, the World Health Organization (WHO), said. Our recent results presented the starting work on textiles treated with natural mosquito repellents that achieved very good efficacy results. This paper deals with cotton fabrics of different density (from 10y/cm to 20 y/cm), using selected repellents (Immortelle oil, Waterglass and Vibroactivated zeolites) for textiles and Immortelle oil for paints, their targeted concentration in the treatment bath, by using WHO modified efficacy method, WHO/ CTD/ WHO PES/IC/96.1 (a metal chamber with flexible one side and top

window for viewing) [4,5]. For this purpose, the scoured and bleached cotton fabric, as the most important textile during the summer time, has been treated in the laboratory scale with mentioned repellents, by using continuous Pad-dry system. For paints for walls, Immortelle oil repellent was applied in the white acrylic and silicate based paints and coated the special paper with layers between 80-160µm, dried on the air. Repellent efficacy measurements for paints were performed for *Aedes albopictus* mosquito, suggested by Giatropoulos et al (2012) [6]. This paper will discuss the repellents efficacy, the changes of textile structure parameters of cotton fabric different in density, the amount of adsorbed agents and SEM images.

2. MATERIAL AND METHODS

Two cotton fabrics of the same construction parameters but different in density (A-higher density, B-lower density) are used for these investigations. They were treated with Vibroactivated zeolites (VZ), Immortelle Oil (I), Waterglass (WG) and mixed these repellents in the impregnation bath, by using Pad-Dry system in Laboratory scale [7]. In this continuous impregnation process, the fabric wet pick was 100%, followed by drying at 120 °C for 2 min. To every impregnation bath wetting agent Felosan RG-N (Bezema) has been added. The samples labels and concentrations of the substances are listed in Table 1.

Table 1. The samples codes and related impregnation bath contents

Sample code	Treated with
UN	Untreated
VZ_20	20 g/l Vibroactivated zeolite
I_5	5 g/l Immortelle essential Oil
I_5_VZ_20	5 g/l Immortelle essential Oil 20 g/l Vibroactivated Zeolite
WG_10	10 g/l Waterglass
I_5_WG_10	5 g/l Immortelle essential Oil 10 g/l Waterglass

This paper discuss the repellent efficacy of cotton fabric samples, for Anopheles spp. and Aedes albopictus mosquitoes, based on different products nature.
For *Anopheles spp* mosquito, the repellents efficacy of cotton fabric is calculated by using the results of WHO modified test method CTD/WHO PES/IC/96.1) which essentially is excito chamber method, where mosquitoes are released from treated fabric. The behaviour of mosquitoes was observed in terms of number of excaped mosquitoes to another space and remain mosquitoes inside of the chamber filled with treated fabric sample. According to WHO method the observation is recordered after 10 and 30 minutes exposure.

For *Aedes albopictus* mosquito was repelled to the bait through the gap provided. In this way their effective repulsion i.e. their ability to migrate away is observed and calculated as Repellent efficacy. The assessment was based as suggested by Giatropoulos et al (2012) [6]. The study was conducted into a cage (33x33x33 cm) with a 32x32 mesh and with a 20-cm diameter circular opening fitted with cloth sleeve. Each cage contained 100 adult mosquitoes (sex ratio 1:1), 5–10-day-old, starved for 12 h at 25±2 °C and 70-80% relative humidity. A plastic glove with an opened space of dimension 5x5 cm was applied for all the bioassays. For positive control it was used Deet reference repellent (N,N-Diethyl-meta-toluamide), which was applied on paper (Whatman chromatography paper) of 24 cm2 total area and tested at two doses: 50 µl (“high”, ≈0.2 µl cm-2 of testing material) and 25 µl (“low”, ≈0.1 µl cm-2 of

testing material) of 100 µg µl-1 stock solution. In each Deet bioassay the paper was placed around the glove opening. This procedure repellents to protect against mosquitoes was conducted on paints. The samples labels, paints and concentrations of the substances are listed in Table 2.
Acrylic and silicate based white *Fasena* commercial paints for walls (Chromos-Svjetlost d.o.o. Company, Luzani, Croatia) with and without repellents were prepared. In 200 g of paints, the appropriate mass of repellant was weighed; stirring for 5 minutes at 1900 rpm with the device Dispermill Yellow Line 2075. After mixing the paint was applied to the paper penetration nozzle 500 cm^2, No. 2805, with a spiral applicator of 80 µm wet film.

Table 2. The samples codes of paints with and without repellents

Sampes	Acrylic and Silicate based Paints	W [%] of Immortelle oil
1.	Fasena Acrylic white	0,0
2.	Fasena Acrylic white	0,5
3.	Fasena Acrylic white	1,0
4.	Fasena Silicate white	0,0
5.	Fasena Silicate white	0,5
6.	Fasena Silicate white	1,0

The samples were dried 96h in the air at room temperature. As repellent, 100% organic immortelle essential oil of domestic production was used.

3. RESULTS

The surface mass of cotton fabrics (A, B), air permeability (according to DIN EN ISO 9237:199512) and pore dimensions values (Bubble Point measurements from Syracuse University) are given in Table 3. Add-on of treated all samples are given in table 4, too.

Table 3. Characteristics of cotton fabrics

Sample	Mass per m^2	Air permeability [$l/m^2/s$]	Pores dimensions [µm]
A	208,42	1261	247
B	148,09	266	110

Table 4. Add-on of treated samples

Samples	Mass per m^2	Add-on [%]
A_UN	208,42	
A _I _5	209,83	0,67
A _WG _10	211,26	1,36
A _I _5 _WG _10	209,57	0,64
B_UN	148,09	
B _I _ 5	150,50	1,69
B _WG _10	149,75	1,18
B _I _5_WG_10	148,43	0,22

During the repellency test procedure, mostly mosquitoes migrated to untreated fabric what contributed to the repellent high efficacy. From Immortelle oil treated cotton, mosquitoes

migrated to untreated cotton already at the very beginning of the applied test (I_5 = 70%). The same phenomenon happened with another treated cotton (Fig. 1). When cotton fabrics were treated with bath consisting of Immortelle oil and Vibroactivated zeolites, they showed a little bit lower efficacy (I_5_VZ_20=60%) but in the case of of the bath with Immortelle oil and Waterglass, the repellent efficacy were incredible 100 %. Cotton fabric with lower density (B) had a lower repellence activity but it is still good. It was not expected as the lighter fabric can't carry the same quantity of wated as the ecte From Tab Add-on This mosquito behavior on textile fabrics can be partly explained by tactile theory.

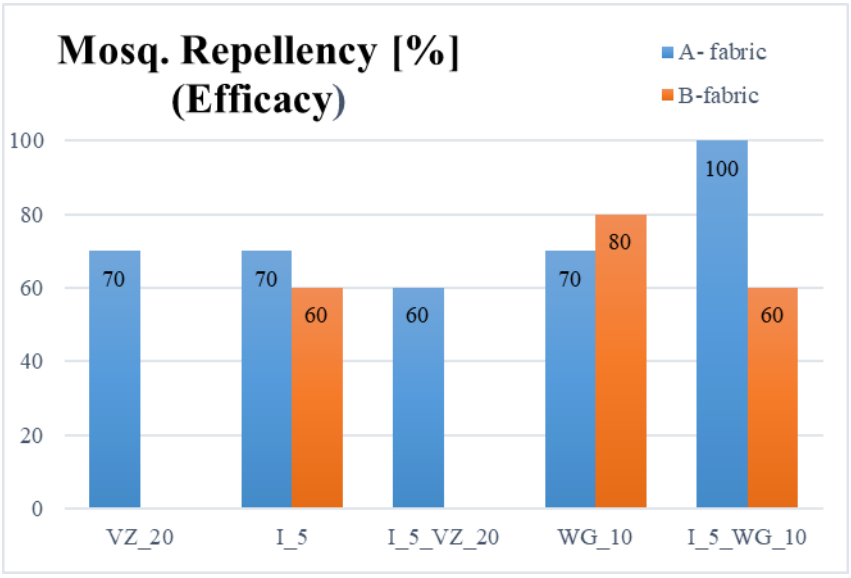
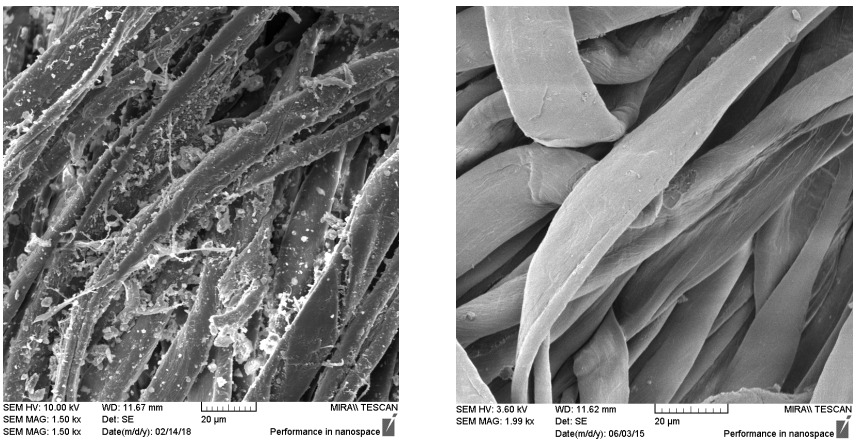


Figure 1. Repellents efficacy for Anopheles spp mosquito repellents on cotton fabric

From SEM images shown in Fig. 2 it is clearly visible that the Vibroactivated zeolites micro - and nano- particles are good distributed on the cotton surface and in a certain way linked with cotton fibre. İn the case of Waterglass it is seen the uniform film around every cotton fibre. Wash cycles test will confirm the the resistance of this film to the washing.
A systematic research work on this phenomenon is a future task of our research work.



a) b)

Figure 2. SEM micrographs of cotton fabric treated with Vibroactivated Zeolites –VZ_5 (a) and Waterglass-WG10 (b)

The best repellent efficacy in this group with paints (Fig 3.), showed both Fasena paints, Acrylic white paint with 1% of Immortelle oil and Silicate white paint with 1% of Immortelle oil, too. It can be said that immortelle oil in applied concentration improves protection of the paints against *Aedes Albupictus*. When concentration of immortelle oil was reduced to 0.5% the results are lower as a good sign Immortelle oil has repellent properties when applied in the higher concentration. For reaching the optimal concentration the additional experiments are neccessary. This was a first attempt to protect paints for walls against mosquitoes and obtained results have shown in which direction the future research work should be targeted.

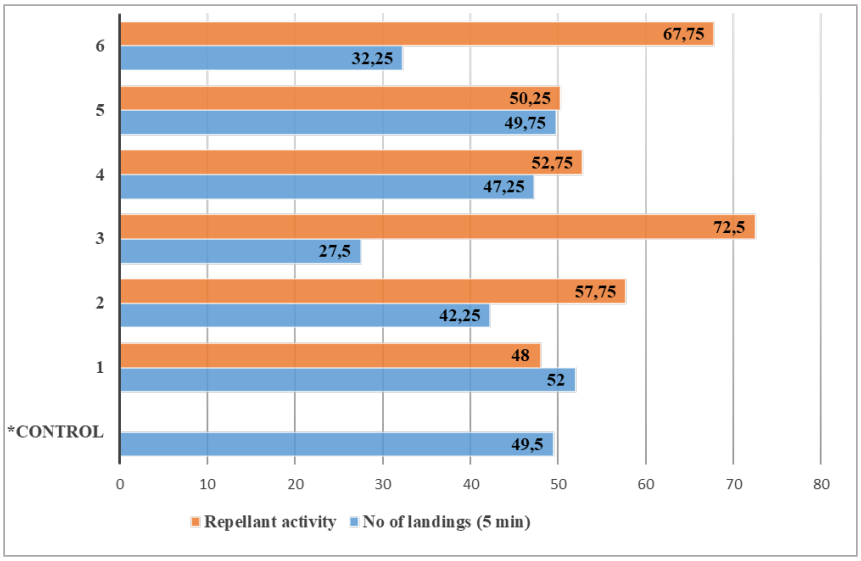


Figure 3. *Aedes albopictus* repellents activity and number of landings on the paper coated with paints for walls

4. CONCLUSION

Cotton fabrics treated with Immortelle oil, Vibroactivated zeolite and Waterglass are successfully applied as efficient repellents against vector-borne diseases transmitted by *Anopheles spp.* mosquitos. During the repellency test procedure, from all treated cotton fabrics most of the mosquitoes migrated to the untreated fabric resulting in high efficacy, even 100%. Cotton fabric density showed expected influence on adsorption of these components but it depends on add-on of the components, too. Based on add-on values of applied mixed repellents and related efficacy results, it could be important to continue this work concerning synergistic or antagonistic effects of mixed these repellents on textiles.
Application of Immortelle oil in the paints for walls showed good repellent efficacy results but the further research work with the higher Immortelle oil concentration and mixed with other repellents should more clarify the repellency of paint for walls, for its persistivity, too.
The Immortelle oil are for the first time successfully applied on paints for walls and given enought good efficacy results for *Aedes albopictus*.

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