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DEVELOPMENT OF SUSTAINABLE ANTIMALARIAL CLOTHING

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ABSTRACT

Today, more than ever, the so called sub-tropical diseases exert a major influence in the quality of life and in the socioeconomic development of a large part of human population. The recent increased resistance to drugs (medicines and repellent agents) and climate changes led to important environmental changes and, consequently, to the spreading of those diseases into new geographical areas, particularly in the outskirts of Europe, never before directly affected by them.

Malaria is one of such diseases. It is caused by a certain type of a plasmodium parasite and is transmitted by the female mosquito bite of the genre *anopheles*. This pathology has a tremendous impact in human health - three millions worldwide deaths per year - and causes significant economic losses. Being aware of this situation, authors envisaged a new technological solution, completely biodegradable, to contribute for the minimization of this problem.

Bearing this purpose in mind, this ongoing PhD thesis aim at the development of a new piece of cloth made with an entirely new family of PLA fibres, specifically designed. Those fibres were embedded with internally developed microcapsules containing a natural repellent agent - *schinus molle* - added during the extrusion process. Based upon this new fibre, three knit structures were produced and the repellent efficacy and washing resistance were assessed.

PLA fibers are increasingly penetrating markets traditionally occupied by petroleum-based synthetics. Poly(lactic acid) is a synthetic polyester derived from renewable sources such as corn. PLA has been used for many years in biomedical applications such as drug release systems, medical implants and surgical sutures because of its biodegradability and biocompatibility.

Considering the necessity of having a fully biodegradable fiber which was capable to endure the thermal and rheological conditions of a melting extrusion process we selected the Biopolymer Ingeo 6201D Fiber Grade PLA from NatureWorks. The main characteristics of the aforementioned polymer are depicted in table1.

Fumed silica microcapsules of 0,3 microns and nanocapsules of 0,007 microns were bought from Sigma-Aldrich. To fill those capsules, two chemical agents were used: the first one was Phermetrin which is non-natural mosquito repellent considered to be the best option for clothing and outdoor. The second one, was the essential oil of aguaribay - *Schinus molle L.* - which is the natural agent we wish to introduce and whose mosquito repellent efficacy we want to study by comparison with the non-natural standard one.

Table 1 - Typical PLA Ingeo 6201D Properties

PHYSICAL PROPERTIES	METRIC	COMMENTS
Specific Gravity	1,24 g/cm^3	ASTM D792
Melt Density	1,08 g/cm^3 at 230ºc	ASTM D1238
Viscosity Measurement	3,1	Relative viscosity; CD Internal Viscotek method
Melt Flow	15-30 g/10 min at load 2,16 Kg and temperature 210 ºC	ASTM D1238
THERMAL PROPERTIES	METRIC	COMMENTS
Elongation at Break	10%-70%	ASTM D2256/ASTM D3822
Tenacity	0,221-0,441 N/Tex	ASTM D2256/ASTM D3822
THERMAL PROPERTIES	METRIC	COMMENTS
Melting Point	160 ºC-170 ºC	ASTM D3418
Glass Transition Temp.	55 ºC-60 ºC	ASTM D3417
Shrinkage	5%-15%	ASTM D32102 Boiling water

The encapsulation of both chemical agents took place individually and was carried out through the adsorption method. The porous silica and the chemical agent were mixed in a 1:1 W/W ratio and agitated for 24 hours at 40ºc. Quality control tests such as DSL, TGA, FTIR and SEM, were conducted in order to characterize the obtained microcapsules.

PLA multifilament with incorporated microcapsules containing a chemical agent was extruded resorting to a 21mm twin screw extruder from Randall Technology Lta. The biopolymer pellets and the synthetized microcapsules were added through independent gravimetric feeders. The linear density, tenacity, elongation at rupture and work at rupture were determined.

Based upon those multifilament and with a Flat V-Bed Electronic Shima Seiki machine model SES 122FF three different knit structures were produced: Jersey; single piqué and French piqué.

Washing fastness and mosquito repellent efficacy using the “arm-in-cage” method as described in the protocol WHO/CDS/NTD/WHOPES/2009.4 are to be done.

This is an ongoing PhD thesis which is not completed and therefore results and conclusions are not yet possible.

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