INCORPORATION OF MICROALGAE IN POLYPROPYLENE BY MELTING PROCESS FOR ANTIBACTERIAL AND SUSTAINABLE TEXTILES

A. Cayla[1], C. Catel[1], V. Laurent[1], G. Guéguéniat [1], C. Campagne[1]

[1] *ENSAIT, GEMTEX, 2 Allée Louise et Victor Champier 59100 Roubaix, France*
aurelie.cayla@ensait.fr

INTRODUCTION

Textiles are used in every area and in several fields, like medical or building, and most of the time an antibacterial property is sought. Usually, silver particles are used because of their efficiency and their thermal resistance. But these particles have an important environmental impact and it is necessary to reduce the use of this material. The main objective of this study is to find a new biocide which is eco-friendly and which can be incorporated in polypropylene (PP) by melt spinning process because this method ensures a sustainable functionalization. The antibacterial agent has to present a good thermal resistance and stability to resist to the spinning process. Furthermore, it has to have no impact on the mechanical and thermal properties of the polymer, while maintaining a correct durability of the product.

Some authors show that chlorellin, an active ingredient contained in the microalgae *Chlorella*, presents interesting antibacterial properties [1-3] and could be used in the spinning process. The algae *Chlorella* does not present antibacterial activity in raw state, chlorellin has to be extracted using a chemical and a mechanical process. The objectives are to extract the chlorellin in order to obtain the antibacterial properties and to keep it after the spinning.

Key Words: Sustainable textile – Antibacterial – Melt spinning – Algae – Chlorellin

1. MATERIALS AND PROCESS

1.1 Algae preparation

The study focused on the use of Chlorella Vulgaris provided by Greensea (Mèze, France). The chlorellin extraction was tested with different solvents: acetone, chloroform, ethyl acetate, ethanol and methanol. The algae powder was suspended in the solvents during 48 hours minimum, and then the solutions were sonicated, centrifuged and filtered to obtain the active ingredient powder (Figure 1).

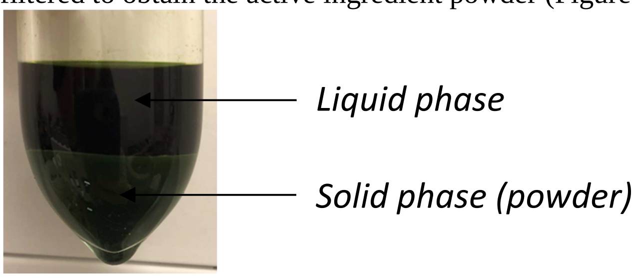

Figure 1. Chlorella-Acetone solution after centrifugation

The antibacterial activities of powders were tested and compared depends on the nature of the solvent. Each chlorellin powder was first characterized alone by agar diffusion test on two types of bacteria: a gram + (S.Epidermidis) and a gram - (E.Coli). For example, the antibacterial activity against S.Epidermidis is illustrated in figure 2. The halo means no bacteria development around powders.

Bacteria	Chloroform extraction	Acetone extraction
S.Epidermidis		

Figure 2. Antibacterial activity of algae powder after chloroform and acetone extracts against S.Epidermidis.

1.2 Multifilaments melt spinning

To obtain an homogenous blend of the polypropylene and the chlorellin, 5 wt.% of each chlorellin extract have been blend by melt process (Thermo-Haake co-rotating intermeshing twin-screw extruder, screw diameter: 16 mm; L/D = 25). These filled PP pellets have been spun into multifilament by melt spinning process at 2.5 wt.% and 5 wt.% of chlorellin.

Then each multifilament was knitted on a rib flat knitting. The antibacterial activity of knit fabrics was defined by agar diffusion test.

2. RESULTS

Spinnability of PP filled with raw or treated algae was tested by Melt Flow Index (MFI) and no significant modification was observed. Mechanical tests proved more conclusive with 2,5wt.% than with 5wt.%: indeed the multifilaments obtained with 2,5 wt.% present a better dispersion of charge, less irregularities on the surface and a better mechanical resistance (Figure 3).

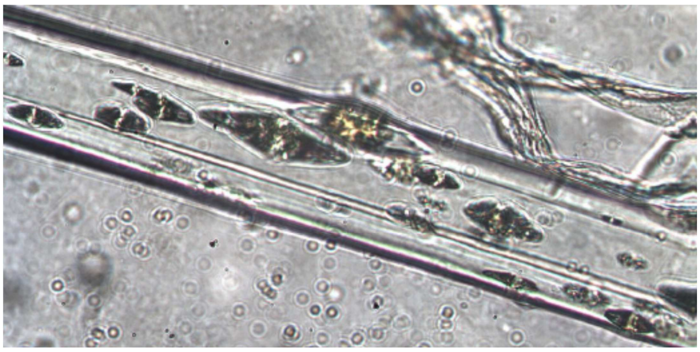

Figure 3. Longitudinal observation of PP+5wt.% Chlorella (*40)

3. REFERENCES

1. Carl Safi, Bachar Zebib, Othmane Merah, Pierre-Yves Pontalier, Carlos Vaca-Garcia, Morphology, composition, production, processing and applications of Chlorella vulgaris: A review , *Renewable and Sustainable Energy Reviews* ,2014, Vol. 35, 265–278.

2. Dieshkumar R, Narendran R, Jayasingam P, Sampathkumar P Cultivation and Chemical Composition of Microalgae *Chlorella vulgaris* and its Antibacterial Activity against Human Pathogens, *Journal of Aquaculture & Marine Biology*, 2017, Vol. 5(3): 00119.

3. Ahmad Mashhadinejad, Hojjatolah Zamani, Jannat Sarmad. Effect of growth conditions and extraction solvents on enhancement of antimicrobial activity of the microalgae Chlorella vulgaris, *Pharm Biomed Res*, 2016, Vol. 2(4): 65-73.

ACKNOWLEDGMENTS

The Duratex project is financed within the Interreg V program France-Wallonia-Flanders, a crossborder collaboration program with financial support from the European Fund for Regional Development, and co-financed by the province of West Flanders and the Walloon Region.