FUTURE BIO-ARCTIC DESIGN – NON-TOXIC PLANT- AND TREE-DERIVED SMART TEXTILES WITH PROTECTIVE PROPERTIES

Kunnas S[1], Korpinen R[2], Pihlava J-M[3], Välimaa A-L[4], Laurila M[4], Sipola R[5], Yliniva J-L[6], Jääskeläinen R[6], Nuutinen A[6], Pietarinen H[6]

[1] *Natural Resources Institute Finland (Luke), Rovaniemi, Finland*
[2] *Natural Resources Institute Finland (Luke), Otaniemi, Finland*
[3] *Natural Resources Institute Finland (Luke), Jokioinen, Finland*
[4] *Natural Resources Institute Finland (Luke), Oulu, Finland*
[5] *University of Applied Sciences Lapland, Rovaniemi, Finland*
[6] *University of Lapland, Faculty of Art and Design, Rovaniemi, Finland*

susan.kunnas@luke.fi

EXTENDED ABSTRACT

Key Words: PLANT-BASED SUBSTANCES, ESSENTIAL OILS, NON-TOXIC PROTECTIVE TEXTILES

1. INTRODUCTION

Today, we are exposed to several thousands of chemicals via e.g. our living environment, cosmetics, textiles and clothing, drugs, and food [1-3]. Most of the chemicals used in textile and clothing production are harmful or dangerous to humans and nature [2-3]. Harmful synthetic chemicals are applied in textiles especially during the finishing procedures e.g. to prevent mold growth in textiles [2-3]. Therefore, natural non-toxic substances are needed in textile production.

The Future Bio-Arctic Design (F.BAD) research is an innovative combination of natural sciences, technology and textile design of the arctic Finnish Lapland area. The F.BAD research idea is to create smart, natural, non-toxic and protective textile material by using arctic tree- and plant-derived raw materials to substitute synthetic chemicals used in textiles. The arctic raw materials have been selected based on their chemical quality and antimicrobial, antifungal and insect repellency properties. The textile materials selected are natural fibres (linen, hemp, nettle etc.) and wool. After extraction by non-toxic and recyclable solvents the functional properties, stability and applicability of tree- and plant-derived bioactive compounds and fibres will be tested including antimicrobial activity, especially antifungal activity, insect repellent properties, and UV-shielding and/or color anti-fading properties. In addition, the use of tree- and plant-based dyes and fibres for textile production (before and after extractions) will be tested. Based on the results, the most potent natural bioactive compounds will be selected and combined with textile production and design.

2. MATERIALS AND METHODS

In the first phase of this study, the aromatic oils of the Arctic Finnish marsh Labrador tea (*Rhododendron tomentosum*) and Bog-myrtle (*Myrica gale*) collected from wild populations in Finland in Northern Ostrobothnia Ylikiiminki and Siikajoki, respectively, were extracted and characterized by the combination of gas chromatography and mass spectrometry (GC-MS). The extraction methods used were steam distillation and supercritical carbon dioxide ($scCO_2$) extraction.

2.1 Steam distillation

Approximately 40-50 g freezed (-20°C) fresh leaves and stems with leaves of Labrador tea (*Rhododendron tomentosum*) and Bog-myrtle (*Myrica gale*) were distilled by steam distillation apparatus for 5 hours. The yields of the aromatic oils obtained are presented in Table 1. The oils were stored in the dark in a freezer (-20 °C) until analyzed by GC-MS.

Table 1. The yields of steam distilled aromatic oils of Finnish marsh Labrador tea (*Rhododendron tomentosum*) and Bog-myrtle (*Myrica gale*).

Plant sample	**Aromatic oils % v/w**	**Aromatic oils w/w**
Labrador tea (stems with leaves)	1,58	1,44
Labrador tea (leaves)	2,00	1,83
Bog-myrtle (stems with leaves)	0,10	0,09

2.2 Supercritical carbon dioxide ($scCO_2$) extraction

Air-dried, pulverized and freezed (-20°C) leaves and stems with leaves of Labrador tea (*Rhododendron tomentosum*) and Bog-myrtle (*Myrica gale*) were placed in $scCO_2$ extraction apparatus for 1 hour extraction program. The temperature of the oven was 60°C, CO_2 flow was 2 ml/min and the input pressure 182 bar while the output pressure was approximately 200 bar. The yields of the aromatic oils are presented in Table 2. The oils were stored in the dark in a refrigerator (+5 °C) until analyzed by GC-MS.

Table 2. The yields of $scCO_2$ extracted aromatic oils of Finnish marsh Labrador tea (*Rhododendron tomentosum*) and Bog-myrtle (*Myrica gale*).

Plant sample	**Aromatic oils w/w dry matter**
Labrador tea (stems with leaves)	13,60
Labrador tea (leaves)	11,01
Bog-myrtle (stems with leaves)	14,15

3. RESULTS AND DISCUSSION

The $scCO_2$ extraction method is better method to produce more essential oil quantities of the Finnish marsh Labrador tea (*Rhododendron tomentosum*) and Bog-myrtle (*Myrica gale*) than traditional steam distillation method. Steam distillation of the two species resulted in less removed material compared to supercritical carbon dioxide ($scCO_2$) extraction. Then again, volatile organic compounds were initially lost in the $scCO_2$ extraction due to the receiver construction. A column packed with absorbable material, for instance ion-exchange resin, needed to be installed.

Thereafter GC-MS analyses indicated similar composition of essential oil compounds which have been reported earlier [4,5]. The next step is to test antimicrobial activity, especially antifungal activity, insect repellent properties, and UV-shielding and/or color anti-fading properties of the essential oils and microencapsulate the functional compounds so they can be added to the textile fibres.

4. CONCLUSION

In summary, chemistry and the properties of the aromatic oil substances of Labrador tea (*Rhododendron tomentosum*) and Bog-myrtle (*Myrica gale*) and the development of the potential non-toxic mosquito repellent and antimicrobial textile finished by microencapsulated essential oils will be introduced.

5. REFERENCES

1. Koniecki D., Wang R., Moody R. P., Zhu J., Phthalates in cosmetic and personal care products: Concentrations and possible dermalexposure, *Environmental Research*, 2011, 111, 329-336.
2. Iadaresta F., Manniello M. D., Östman C., Crescenzi C., Holmbäck J., Russo P., Chemicals from textiles to skin: an in vitro permeation study of benzothiazole, *Environmental Science and Pollution Research*, 2018, 25, 24629-24638.
3. *Chemicals in Textiles – Risks to human health and the environment*, report 6/14, KEMI – Swedish Chemical Agency, Stockholm, 2014.
4. Svopoda K. P., Inglis A., Hampson J., Galambosi B., Asakawa Y., Biomass Production, essential oil yield and composition of Myrica Gale L. harvested from wild populations in Scotland and Finland, *Flavour Fragr. J.*, 1998, 13, 367-372.
5. Jaenson T. G. T., Pålsson K., Borg-Karlson A.-K., *Evaluation of extracts and oils of tick-repellent plants from Sweden*, *Med Vet Entomol*, 2005, 19, 345–352.