
Future
Bio-Arctic Design
funktio3

Future Bio-Arctic Design II

The Future Bio-Arctic Design II (F.BAD II) project funded by the European Regional Development Fund is another step in the research and development of Lappish textile innovations. In the project, new environmentally friendly green chemistry solutions for smart textiles have been created in collaboration between the Natural Resources Institute Finland (Luke), the Faculty of Arts of the University of Lapland and the University of Applied Sciences of Lapland as well as a network of companies.

The F.BAD project, which ended in autumn 2021, studied compounds from the plants of the North which could replace harmful finishing chemicals currently used in the textile industry. In the project's smart applications, the potential of extracts from northern plants such as Angelica (*Angelica archangelica* L.) and Marsh Labrador Tea (*Rhododendron tomentosum*) as organic antibacterial and mould inhibitors or insect repellents became significant. For example, antibacterial and textiles suitable for repelling insects already exist but they are often made of environmentally harmful compounds.

"The F.BAD II project produced the first product prototypes in close cooperation with companies. Entrepreneurs in textile, clothing and natural product industries created innovative products from the perspective of their own businesses, and we researchers were able to test the coating techniques we have developed on a larger scale for prototypes. In addition to this, the study explored the smart properties and durability of the textile materials,
as well as the environmental impacts."

Research Scientist Susan Kunnas, Luke

As a result of F.BAD II -project, five product prototype entities were produced:

1. Rovaniemi-based Oooza Design created the Marsh Labrador tea (Suopursu) jewellery series made from birch and birchbark, which repels mosquitoes because of its scent. Design and production: Minna Kovero, Oooza Design. Coatings: Luke.

2. A felted yoga mat with a filling made of reindeer hair and sheep's wool by the Kaamoskehrä-cooperative in Salla. In the reindeer skin parts, an antibacterial Angelica leather care agents produced during the F.BAD II - project were used and the smell of northern Marsh Labrador tea can be added to the yoga mat if desired. Design and production: Mirja Kelloniemi, Kaamoskehrä and Lapland UAS. Pattern design of the cotton-wool-textile parts: *Molecules & Bugs*, Erja Sainio, 2022. Fabric weaving: Annala Oy. Coatings: Luke and Lapland UAS.

3. Antimicrobial cotton-linen travel pillows stuffed with buckwheat chaff in collaboration between the Ivalo-based companies Jaatu and HEMPEA. The functionalization of the fabrics was executed by Marsh Labrador tea microcapsules and solution impregnation techniques. Design and production: Marja-Maija Valtonen and Janna Björkvist. Pattern design: *Molecules & Bugs*, Erja Sainio, 2022. Fabric weaving: Jokipiin pellava Oy. Coatings: Luke.

4. Antibacterial set of Tencel-spandex undergarments by Kniteco Oy in Liperi. The functionalization of the fabrics was executed by Marsh Labrador tea solution impregnation technique. Design and production: Kniteco Oy. Coatings: Luke.

5. An outdoor furniture prototype with Marsh Labrador tea antimicrobial treatment was made in cooperation by Ostrobothnia companies. Wool-cotton fabric weaving for the Havue Collection Elokuu-chair: Annala Oy. Pattern design: *Virta*, Kirsi Eskelinen. Upholstery design and manufacture: Uni Lapland. Coatings: Luke. First generation textile filling: FluffStuff Oy.

Business development is crucial in strenghtening the natural product sector

Reeta Sipola, Master of Natural Resources, Specialist, Future Bioeconomy, Lapland University of Applied Sciences

The activities of the project partner Lapland University of Applied Sciences focus on the smart use of natural resources and promote sustainable and versatile utilization of regional resources. From the perspective of regional development, the Lapland UAS objective is to carry out research openings on the basis of which sustainable business can be created.

Natural resource companies are small and production chains in the sector from primary production to larger scale and high-level processing need to be strengthened. The development of local further processing adds value to the region's raw materials and enables new business activities. Biolab, a joint collaboration between Lapland UAS and the Arctic Centre, opened in 2022, will provide even better support for the development of livelihoods and research.

The Lapland UAS has analysed samples prepared in the F.BAD II project using various imaging methods and conducted weathering and tensile properties testing on them. In addition, the responsibility has included mapping the availability of raw materials for the plant extracts studied as well as the modelling of the production and business chains required for their procurement.

Towards sustainable production of value-added products with green chemistry methods and extraction techniques

Susan Kunnas, Dr., Research Scientist, Natural Resources Institute Finland

The Natural Resources Institute Finland (Luke) is the main coordinator of the F.BAD II project. One of the strategic priorities of Luke's research on biocircular economy is to make holistic use of the entire biomass and to generate added value by also using it in products with the highest possible refining value. In the applications of the F.BAD II project, the use of plant extracts from the North as organic antimicrobial coatings and mosquito repellents, for example in the textile and clothing industries, is significant.

Luke's core competencies in the F.BAD II project include green chemistry extraction methods using only non-toxic and recyclable solvents, testing the composition, chemistry and bioactivities of the extracts and textiles, and attaching extracts in an environmentally friendly way to textile fibres using microencapsulation and impregnation techniques. In addition, Luke has explored the preliminary environmental impacts and legislative process for the production of the functional textiles.

Mosquito-repelling jewellery and antibacterial textiles

Heidi Pietarinen, PhD (Arts), Professor, University of Lapland, Faculty of Art and Design

The northern Labrador tea (*Suopursu)*-jewellery series, made of birch and birchbark, repels mosquitoes with its scent. Antibacterial treatment of a travel pillow, yoga mat, jacquard woven upholstery fabric or knitted set of undergarments does not provide for development of microbes but increases the textiles freshness.

FUNCTION³ is the final exhibition of the *Future Bio-Arctic Design II (F.BAD II*) project in the galleries *Hämärä* and *Seinä* of the University of Lapland from 5 to 21 September 2023. It is a joint project between the Natural Resources Institute Finland, the University of Applied Sciences of Lapland and the Faculty of Art and Design of the University of Lapland. The project combines the experimental interaction between science and art, i.e. new forms of expression and technologies.

The University of Lapland's core competence in the F.BAD II project is fashion, textile design, materials research and jacquard-weaving technology. Material research and technology can be used to develop innovative design between human, nature and non-human, such as materials developed by nature itself, microbes or living organisms, with plants in Northern Finland. This can bring about new design solutions and changes towards sustainable processes. Multidisciplinarity, multi-methodology and interdisciplinarity are key elements.


The midnight
sun
in Finland…


…offers
unique
conditions…


…during
short
growing
season


Angelica
(*Angelica archangelica*)



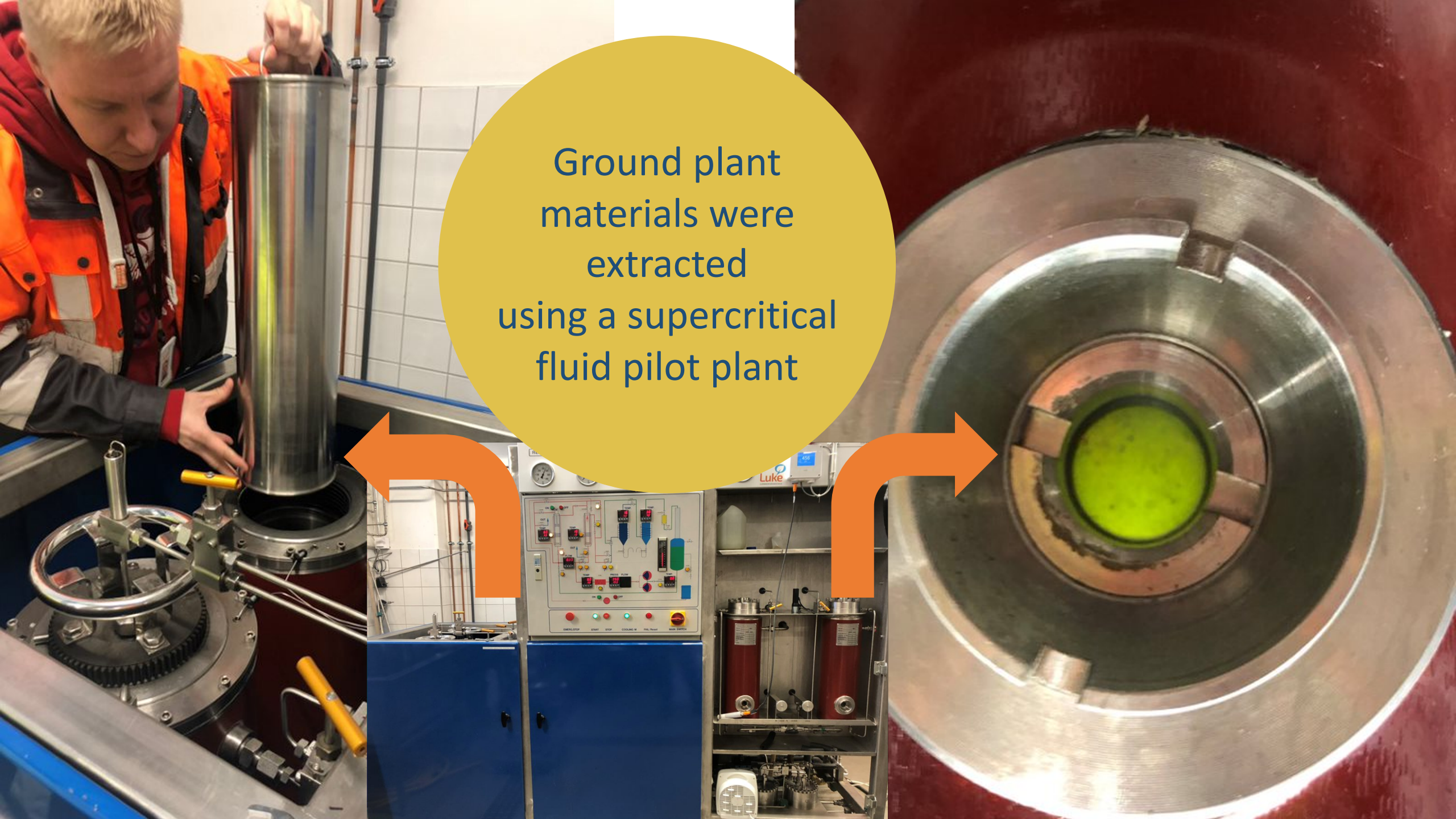
The roots of Angelica
were cultivated
and pre-treated
by Arctic Warriors Oy
(Narkaus, Lapland)

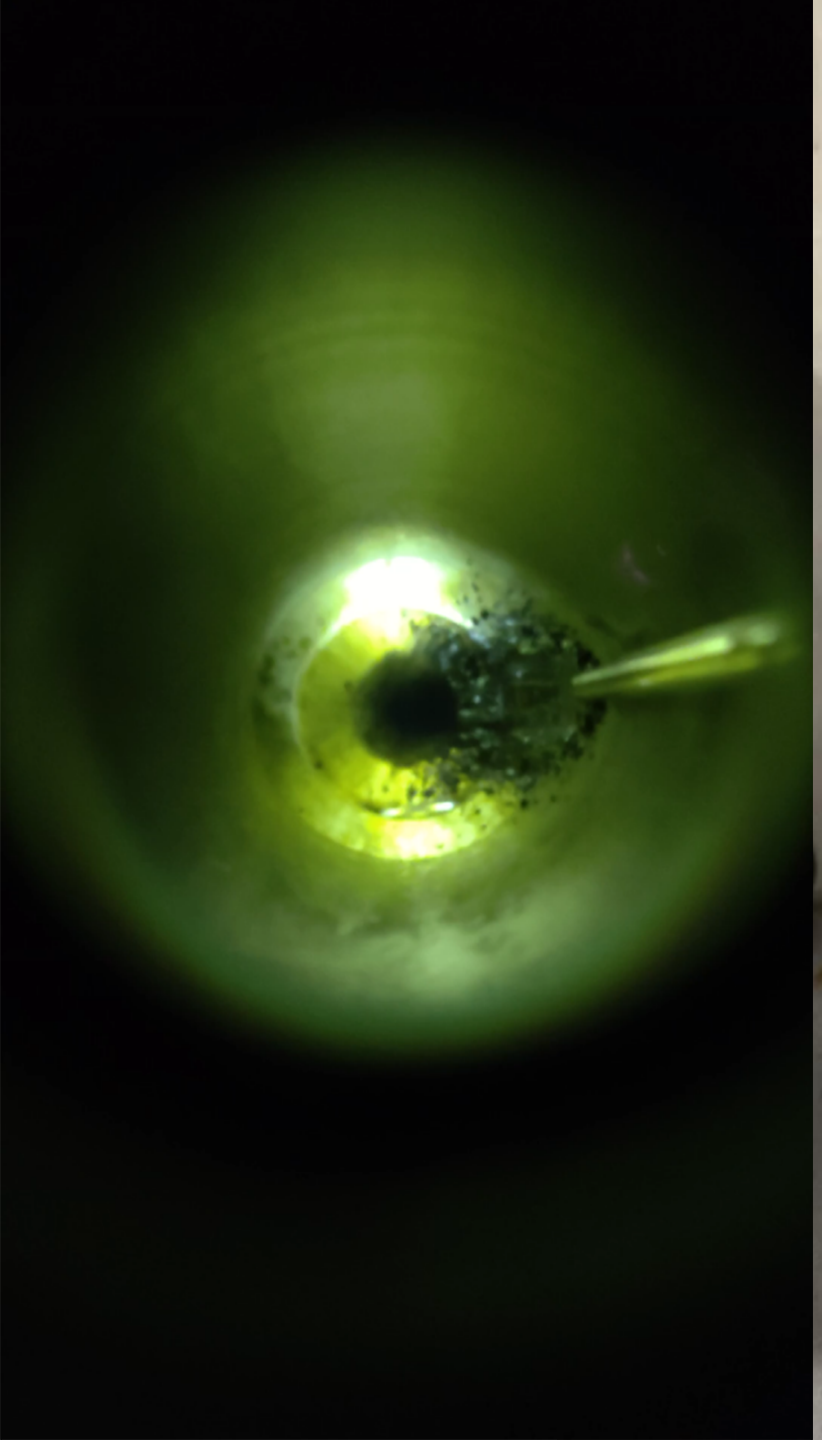

Marsh Labrador Tea
(*Rhododendron tomentosum*)


The Marsh Labrador Tea shoots were collected from wild populations by 4H Oulu in Finland in Northern Ostrobothnia



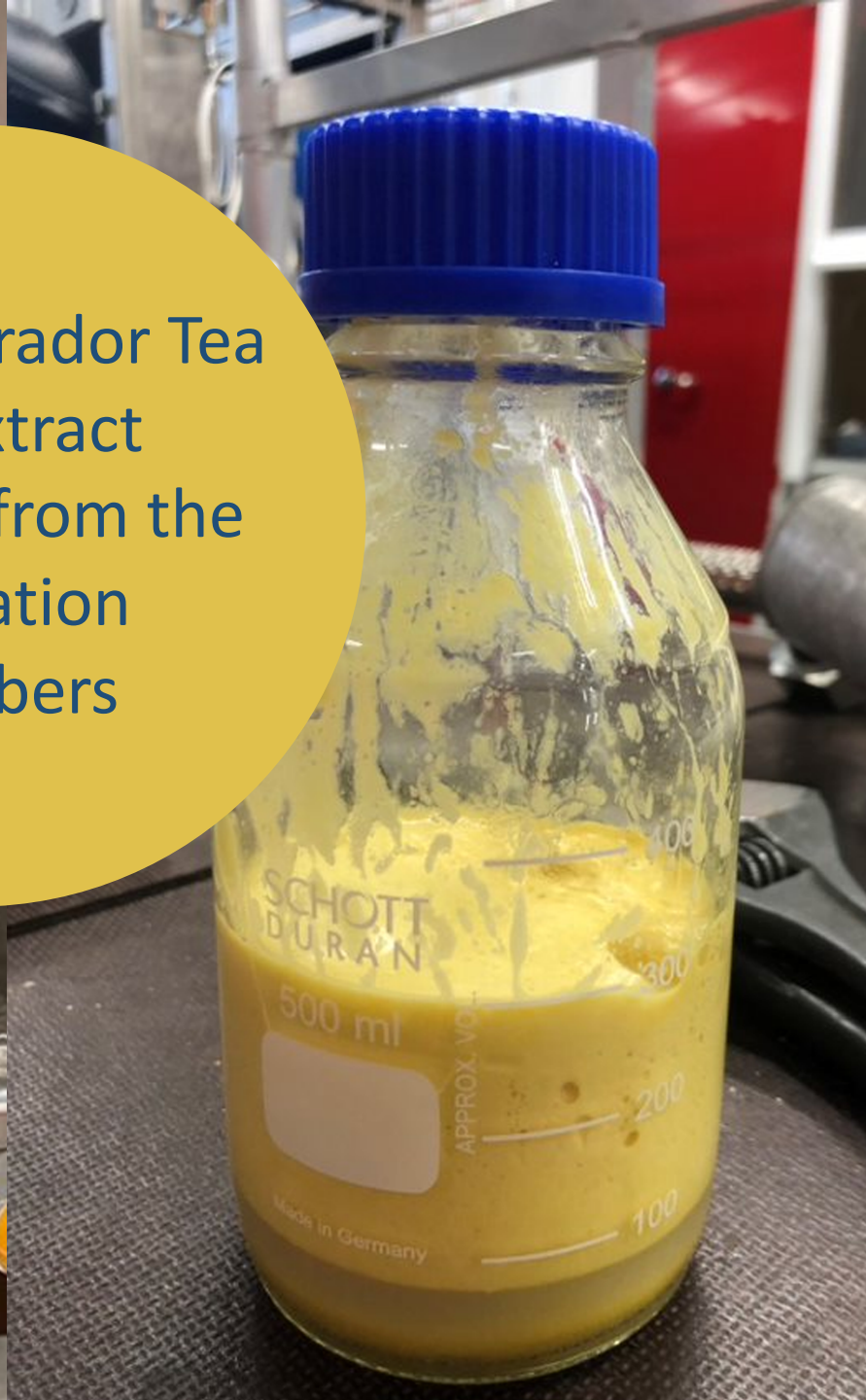
The air-dried plant materials were delivered to the Luke's extraction team of Bioruukki


Ground plant materials were extracted using a supercritical fluid pilot plant



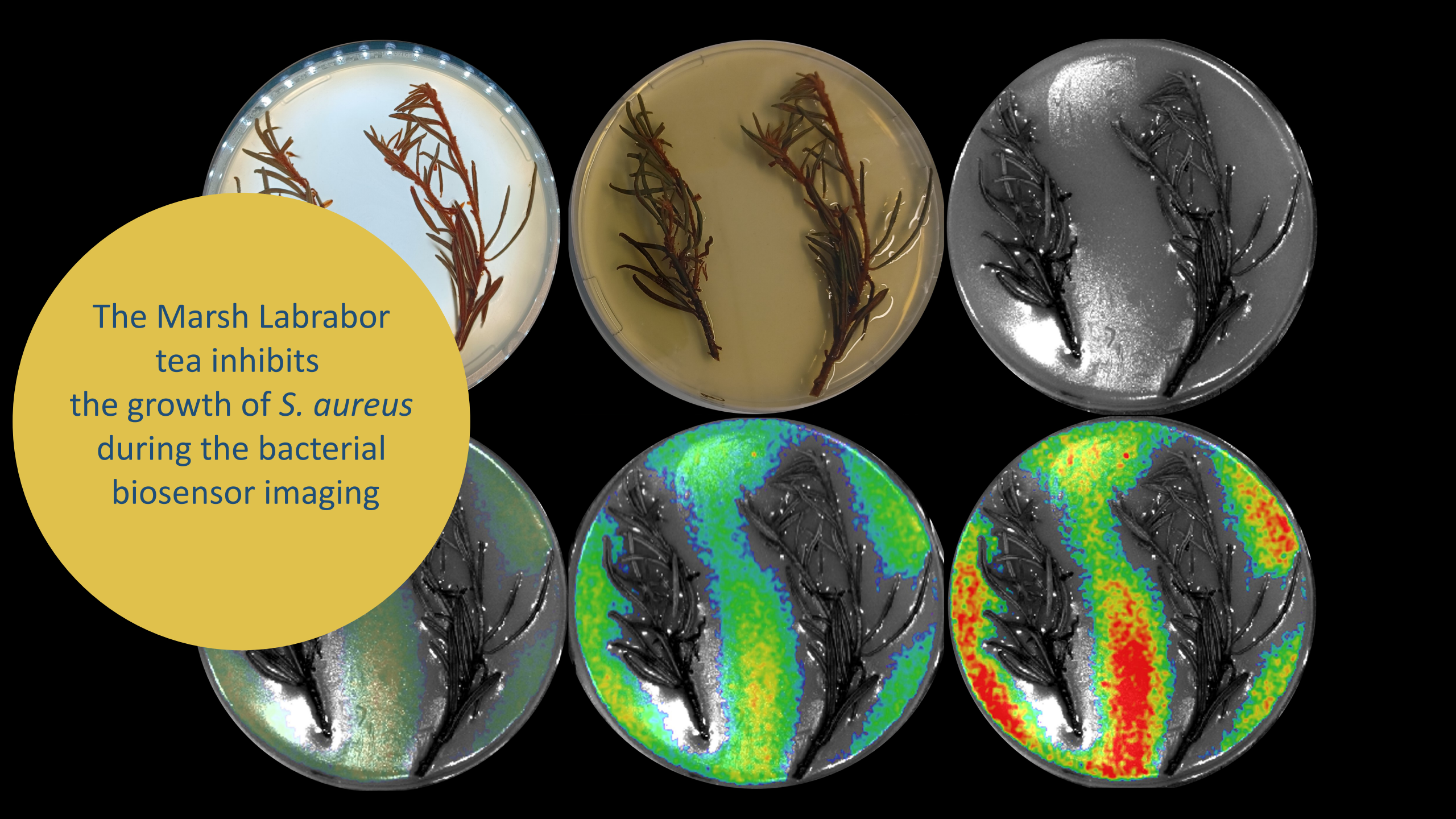


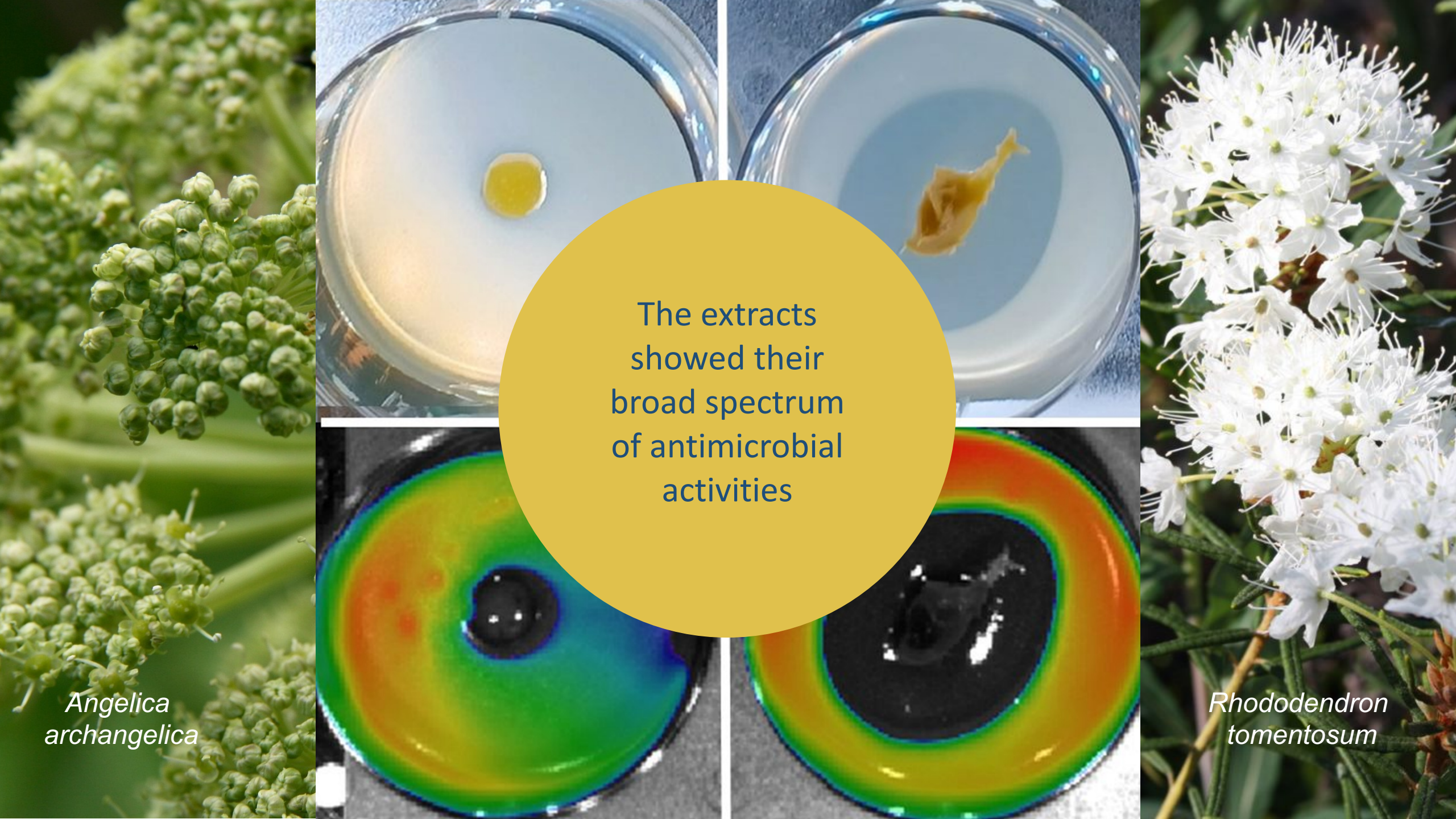
Marsh Labrador Tea wax extract collected from the separation chambers



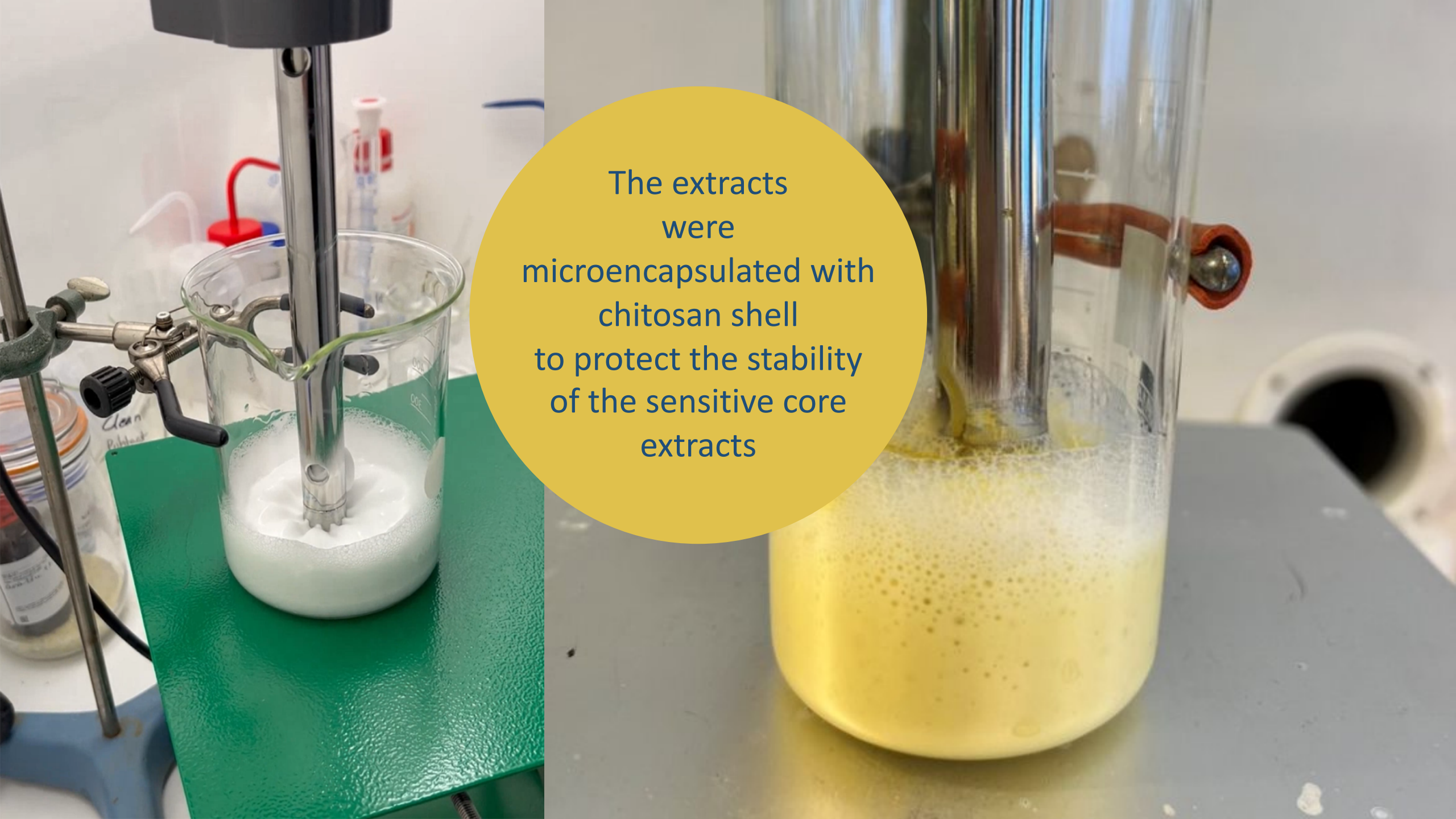

The Angelica root oil
after the extraction
Väinönputken juuri
1. uutto
07.02.22


”The compounds and properties of the plants generated by the midnight sun” were transferred to the extracts

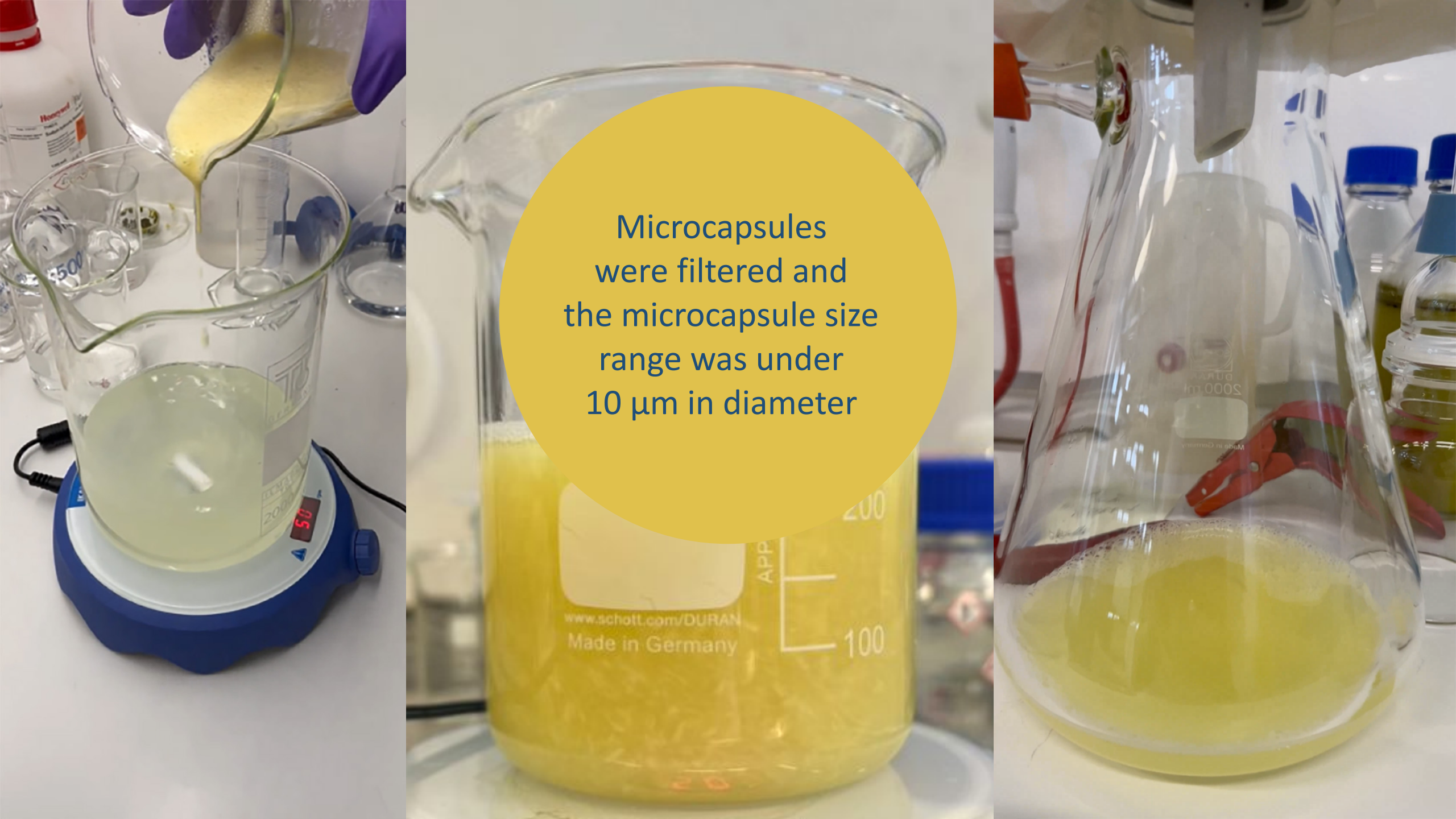

The Marsh Labrabor tea inhibits the growth of *S. aureus* during the bacterial biosensor imaging


The extracts showed their broad spectrum of antimicrobial activities
Angelica archangelica
Rhododendron tomentosum


The composiotions
of the extracts
were characterized
by combination of gas
chromatography and mass
spectrometry (GC-MS)



The extracts
were
microencapsulated with
chitosan shell
to protect the stability
of the sensitive core
extracts


Microcapsules
were filtered and
the microcapsule size
range was under
10 µm in diameter
www.schott.com/DURAN
Made in Germany
200
100

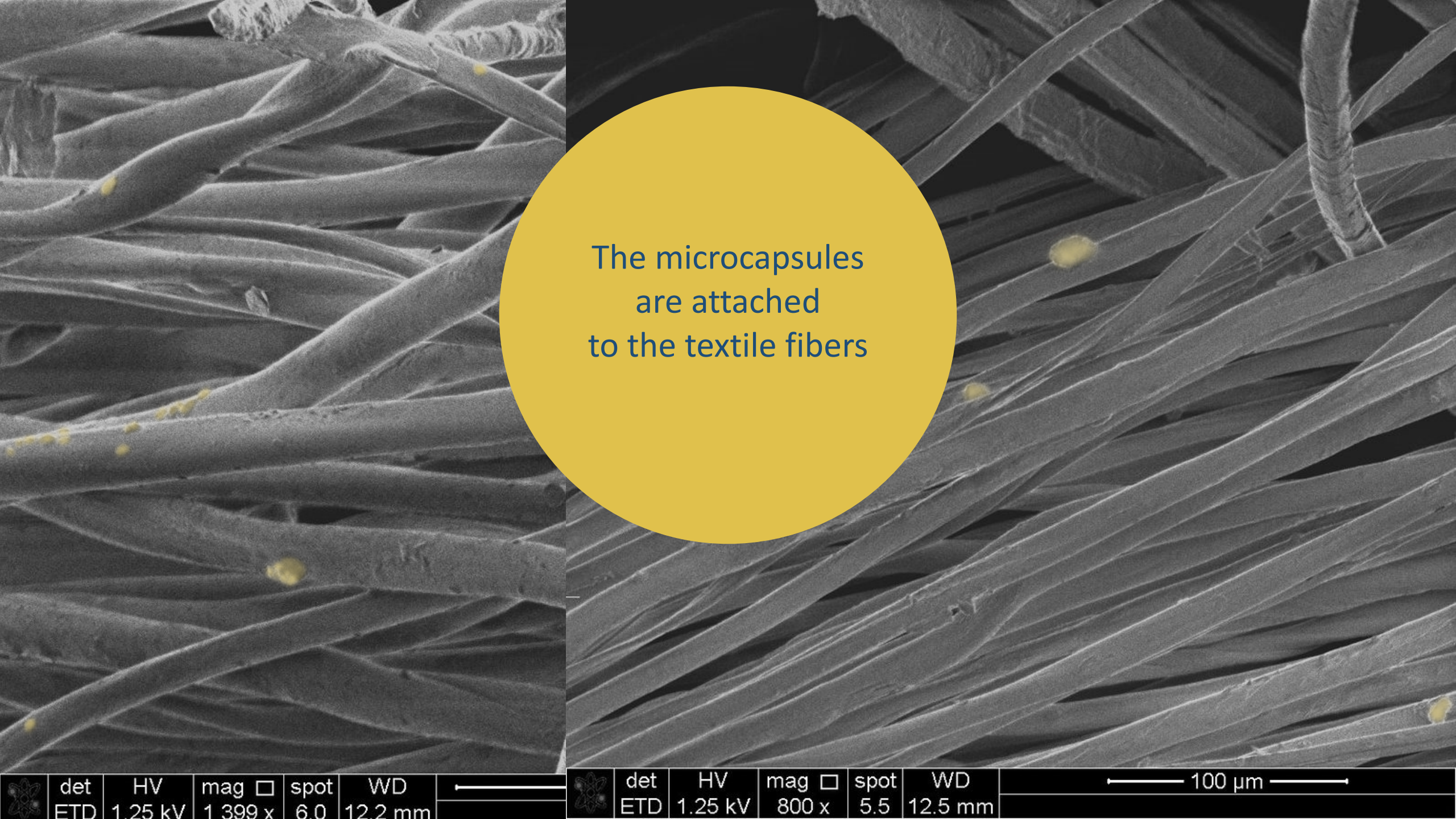


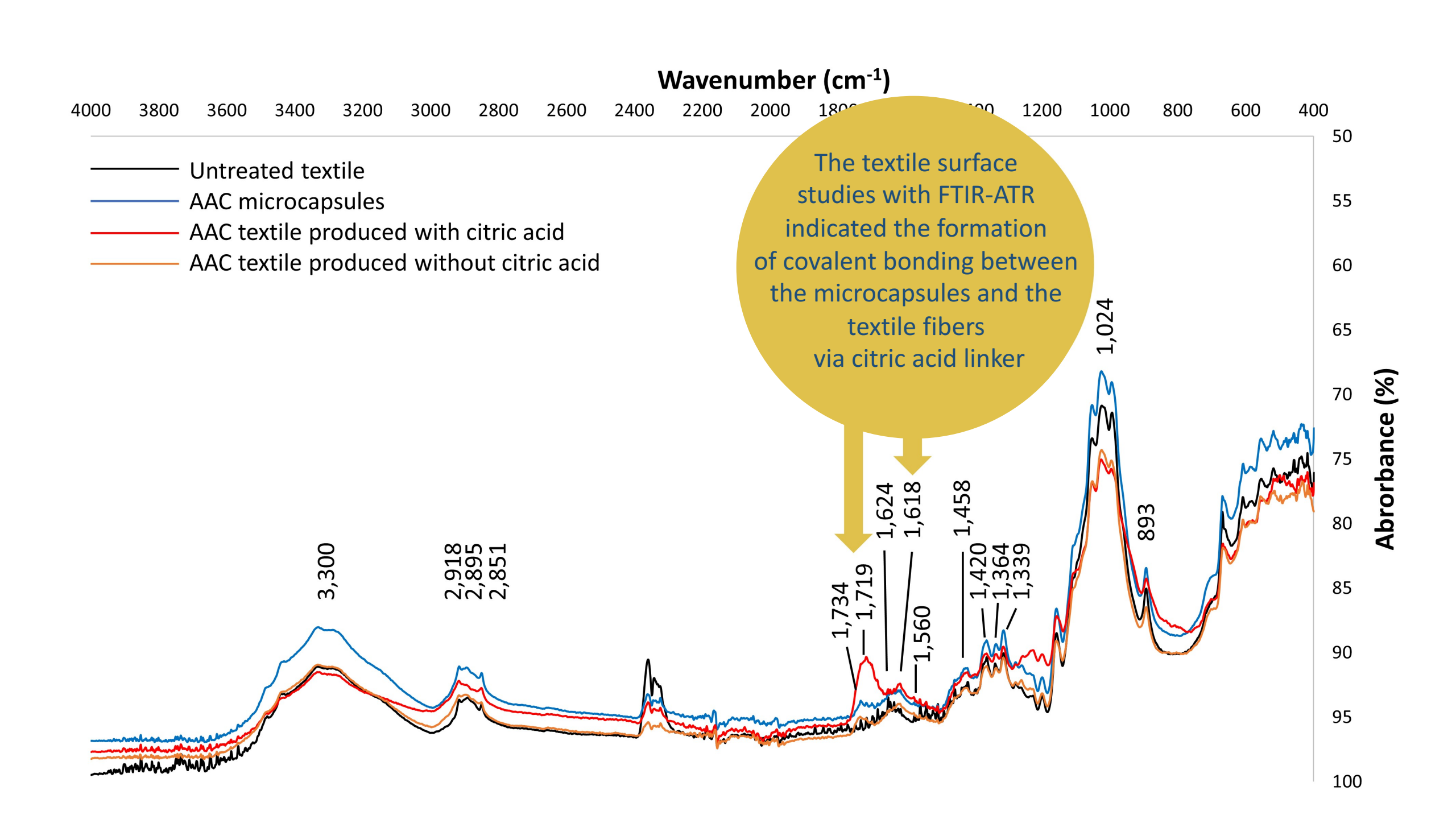
The impregnation of the extracts and the microcapsules onto the textile fibers

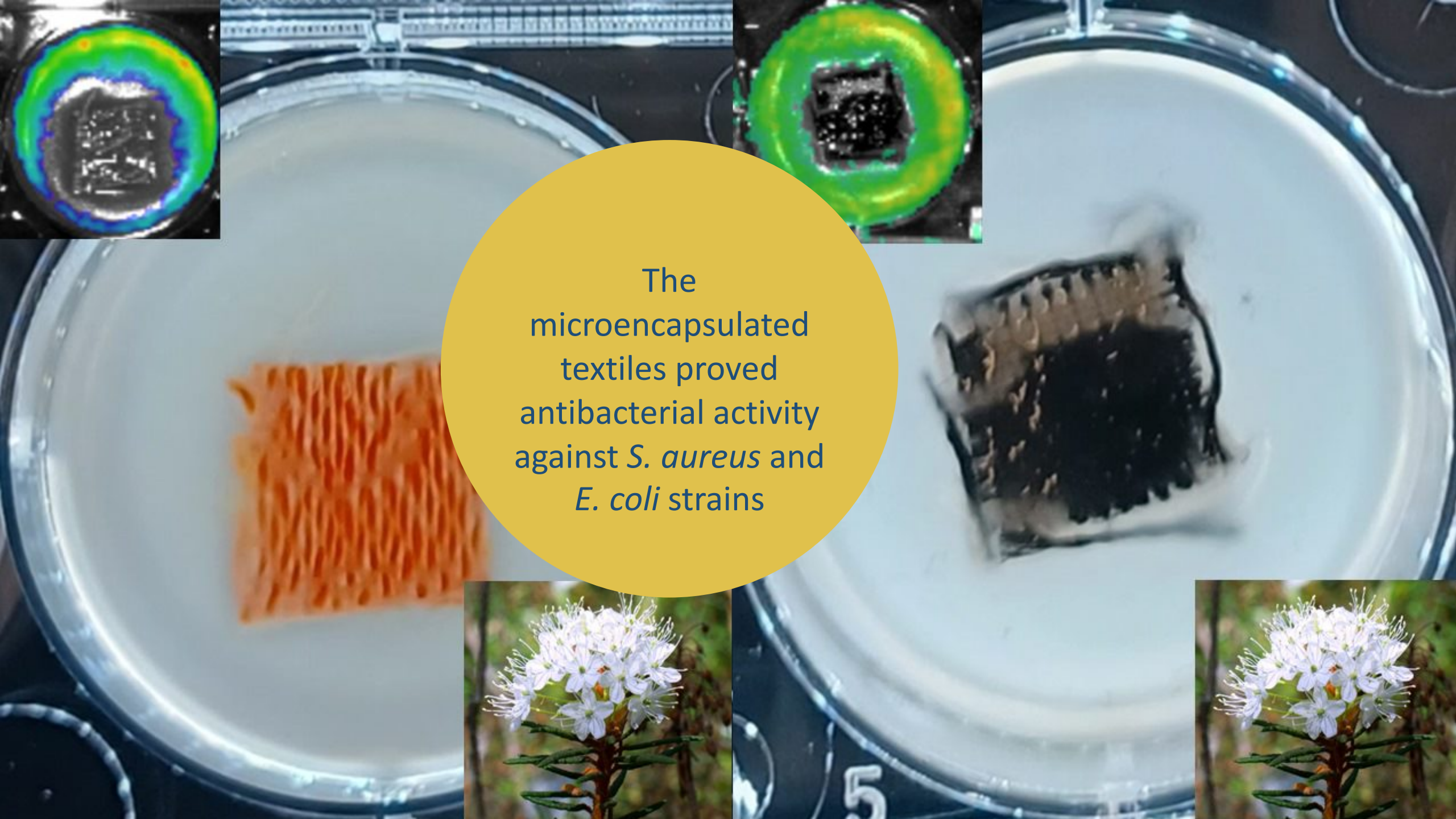

The coatings
were also carried out
in companies


The fabric has
a dirt and water
repellency treatment


The surfaces
of the textile samples were
examined
with a FESEM at
Lapland University of
Applied Sciences
THE PERIODIC TABLE OF THE ELEMENTS

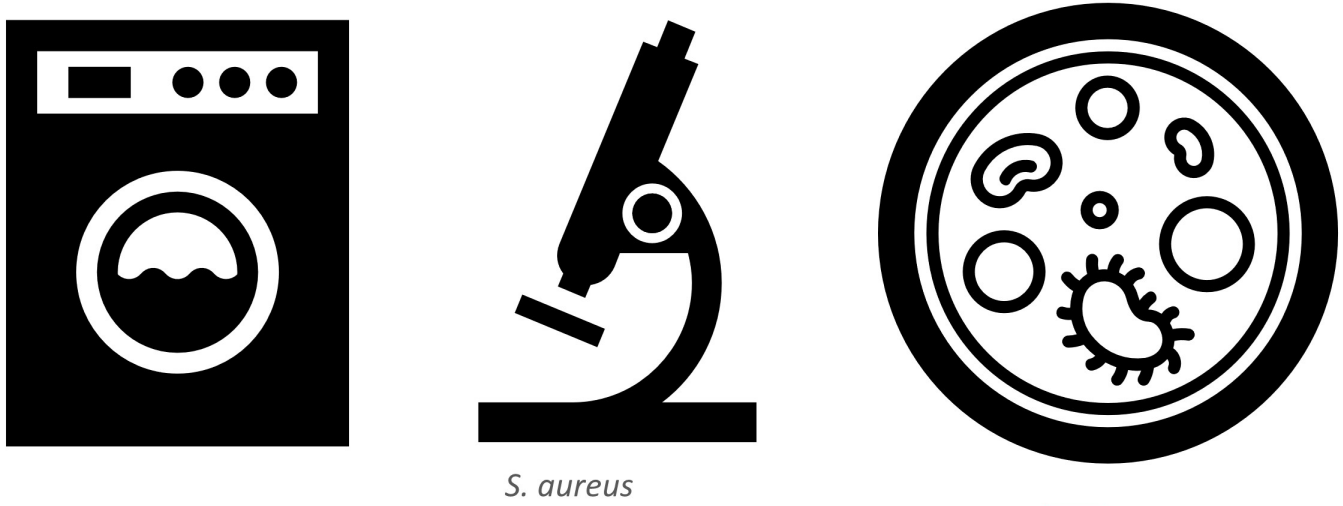

The microcapsules
are attached
to the textile fibers
det
ETD
HV
1.25 kV
mag
1 399 x
spot
6.0
WD
12.2 mm
det
ETD
HV
1.25 kV
mag
800 x
spot
5.5
WD
12.5 mm
100 µm


Wavenumber (cm-1)
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1200
1000
800
600
400
Untreated textile
AAC microcapsules
AAC textile produced with citric acid
AAC textile produced without citric acid
The textile surface studies with FTIR-ATR indicated the formation of covalent bonding between the microcapsules and the textile fibers via citric acid linker
3,300
2,918
2,895
2,851
1,734
1,719
1,624
1,618
1,560
1,458
1,420
1,364
1,339
1,024
893
50
55
60
65
70
75
80
85
90
95
100
Abrorbance (%)

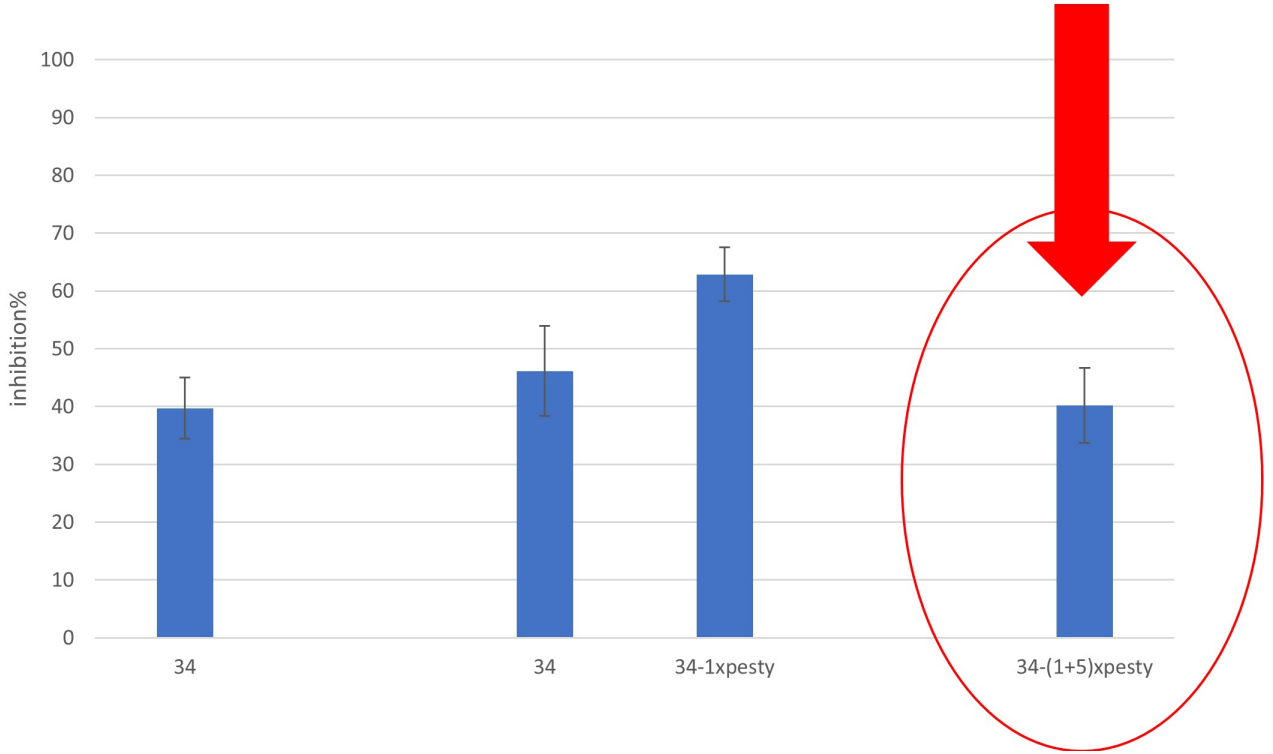

The microencapsulated textiles proved antibacterial activity against *S. aureus* and *E. coli* strains

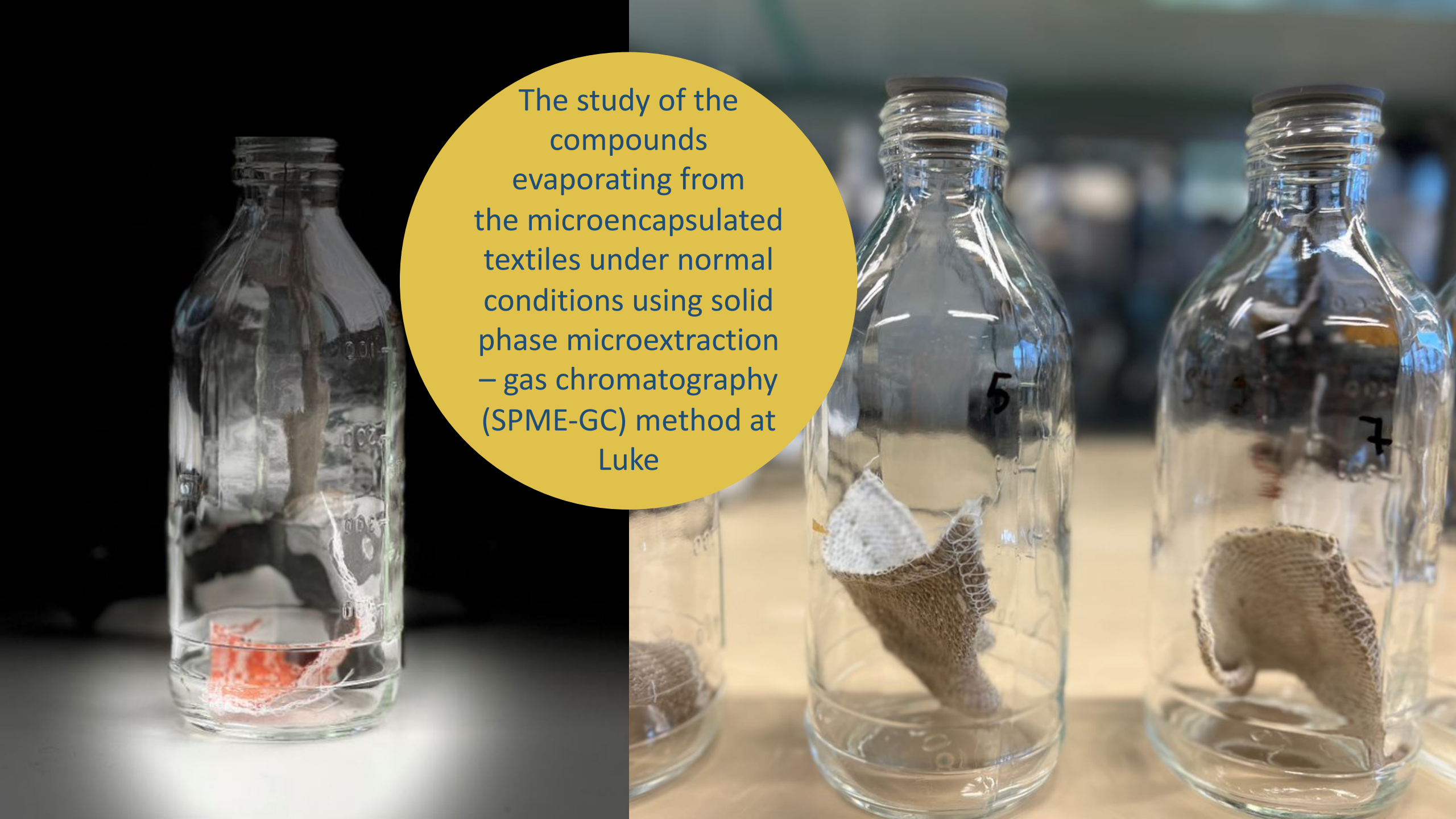


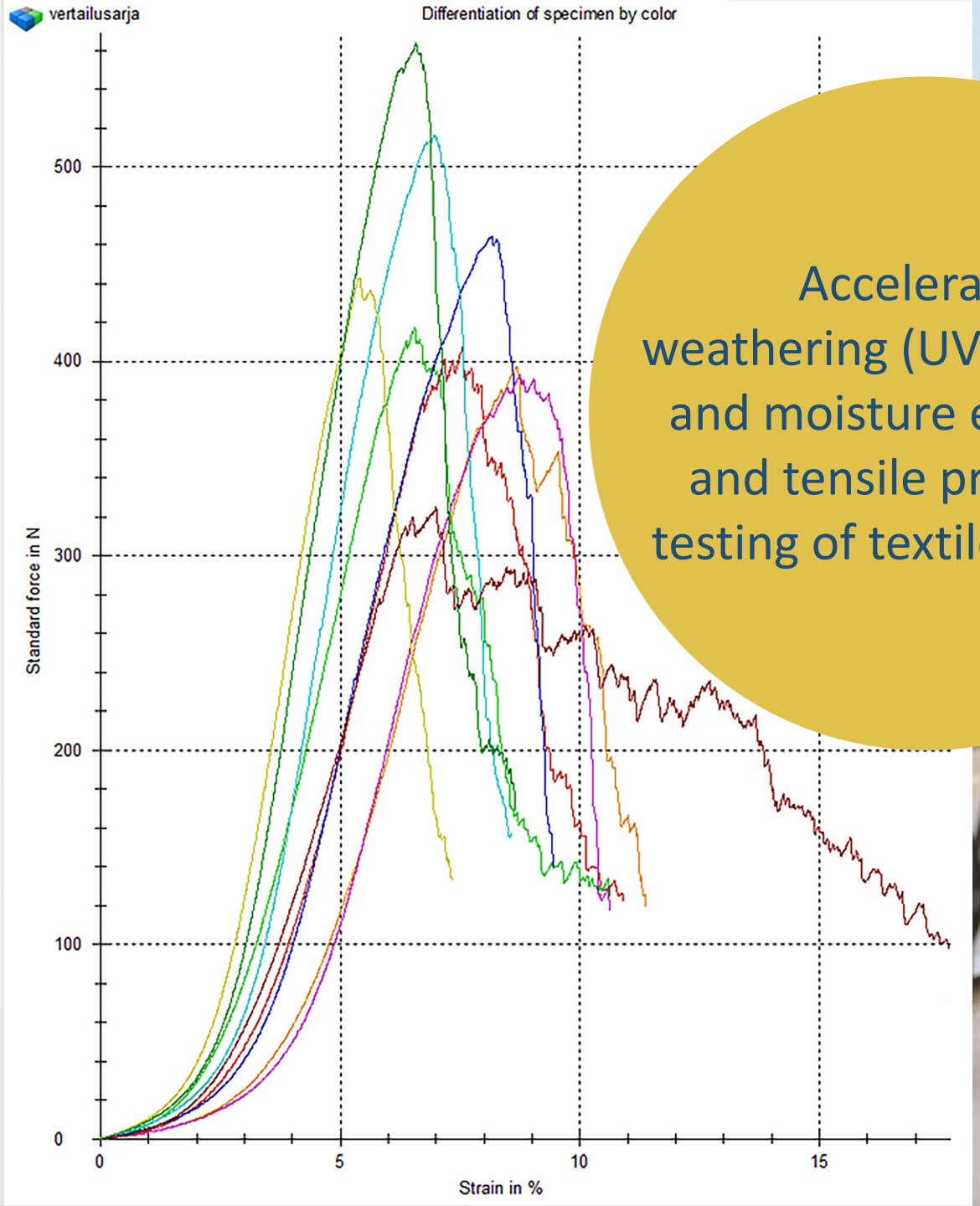
The microencapsulated fabrics proved the antibacterial activity against *S. aureus* after 6 domestic washing and drying cycles



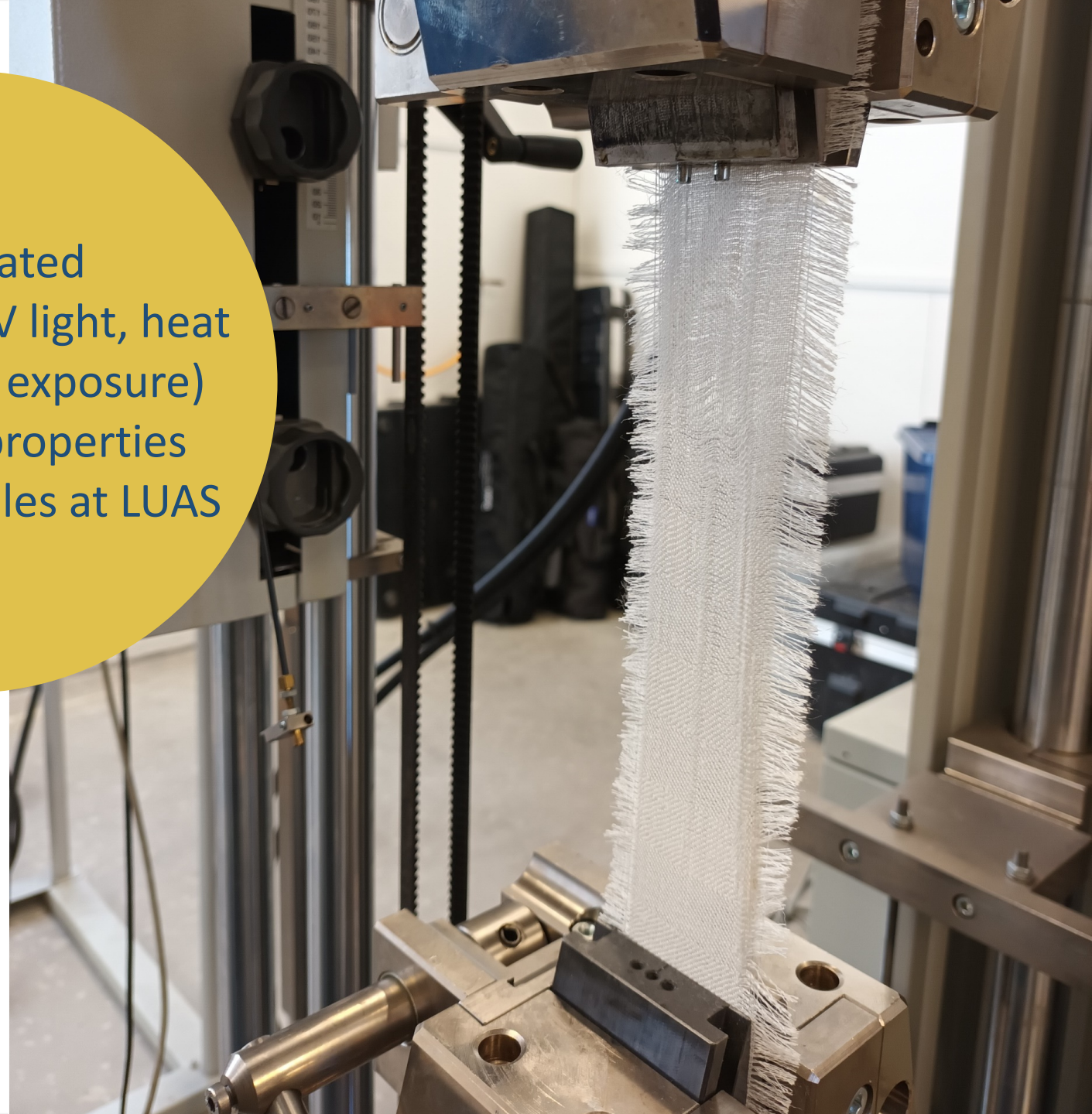
S. aureus




The study of the compounds evaporating from the microencapsulated textiles under normal conditions using solid phase microextraction – gas chromatography (SPME-GC) method at Luke



Accelerated weathering (UV light, heat and moisture exposure) and tensile properties testing of textiles at LUAS



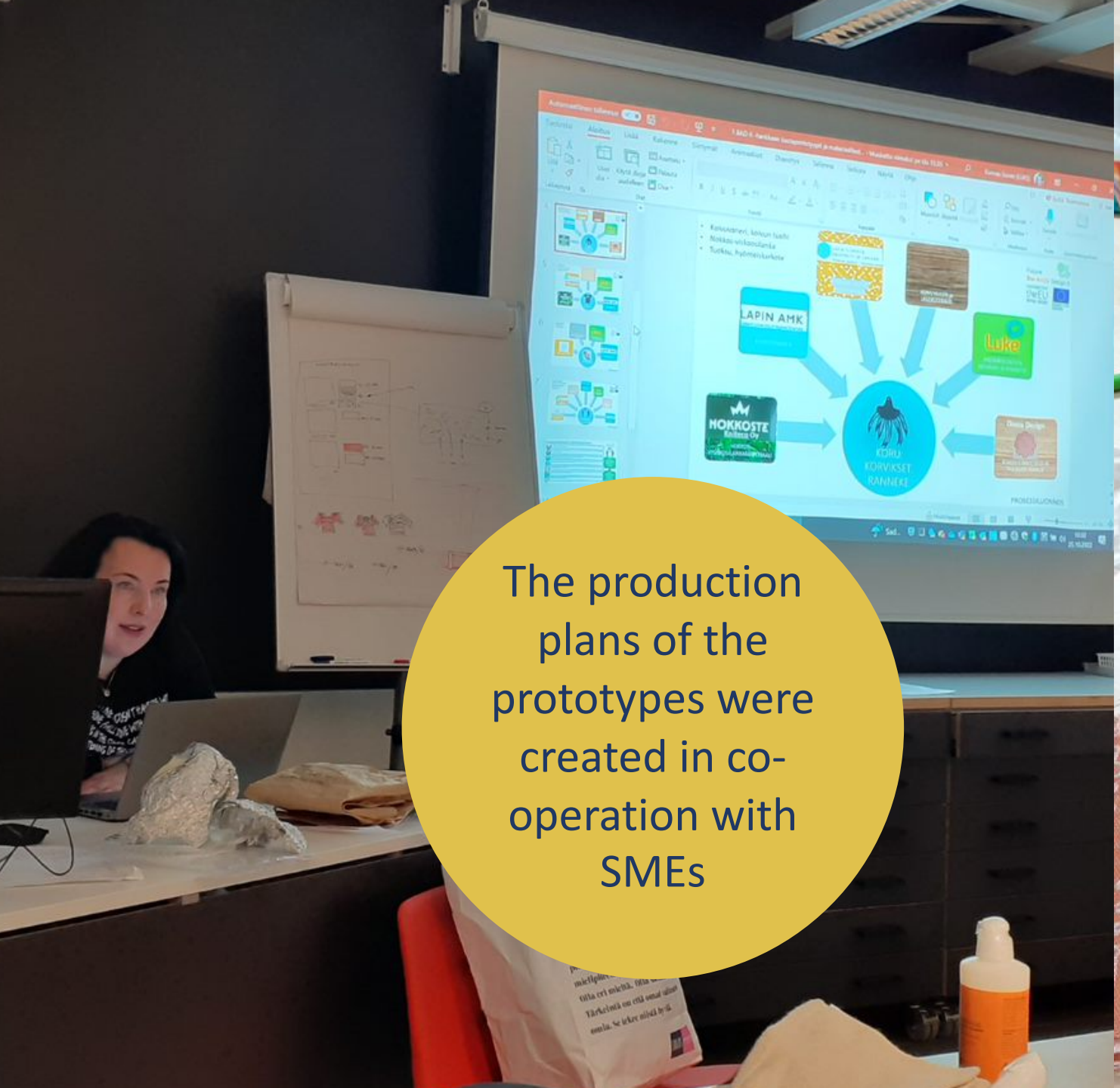

Workshop I:
Entrepreneurs designing product prototypes at the University of Lapland


The quick
prototyping was
a success!
maxell



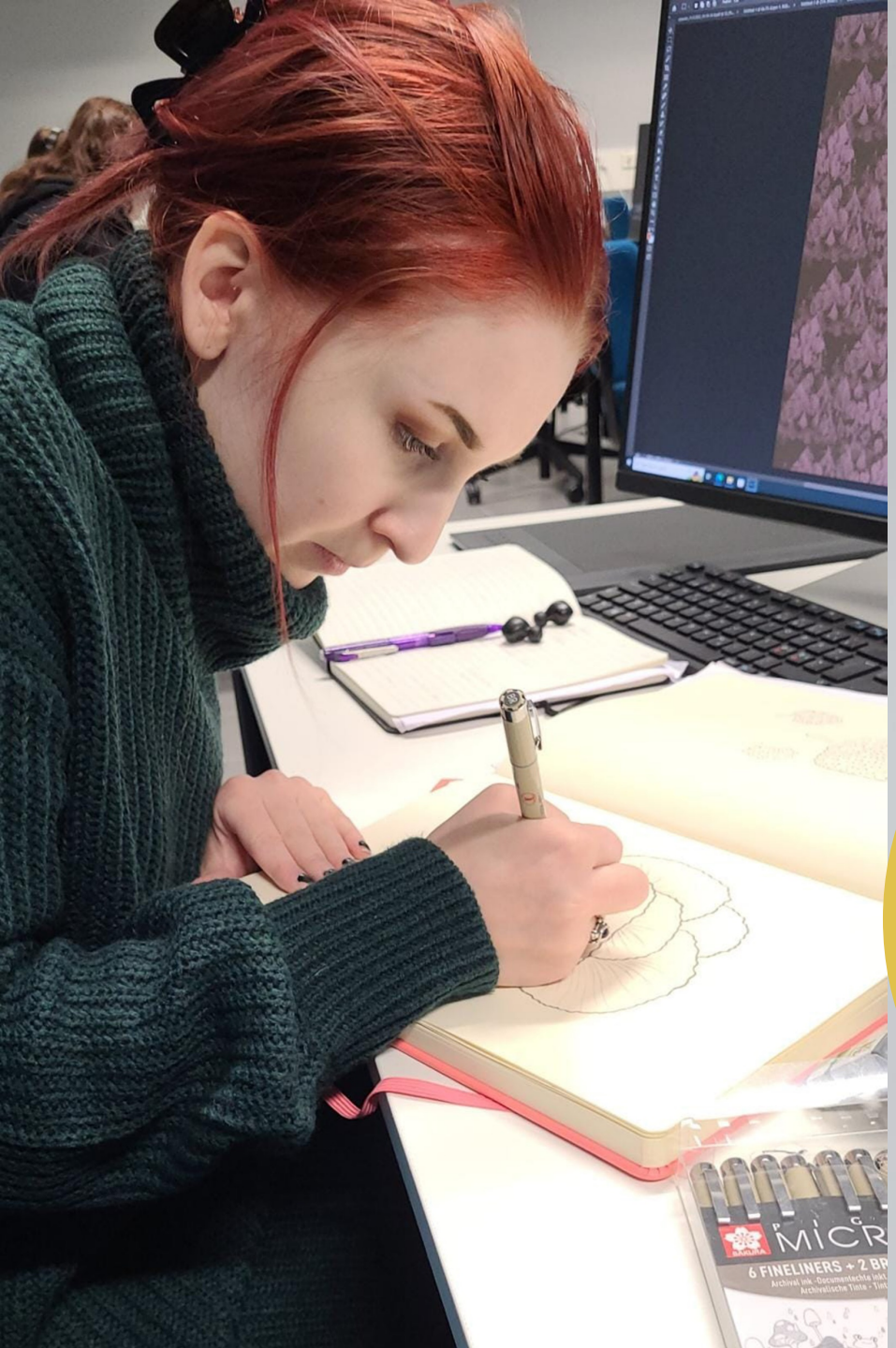


Workshop II:
The extracts meet
the materials



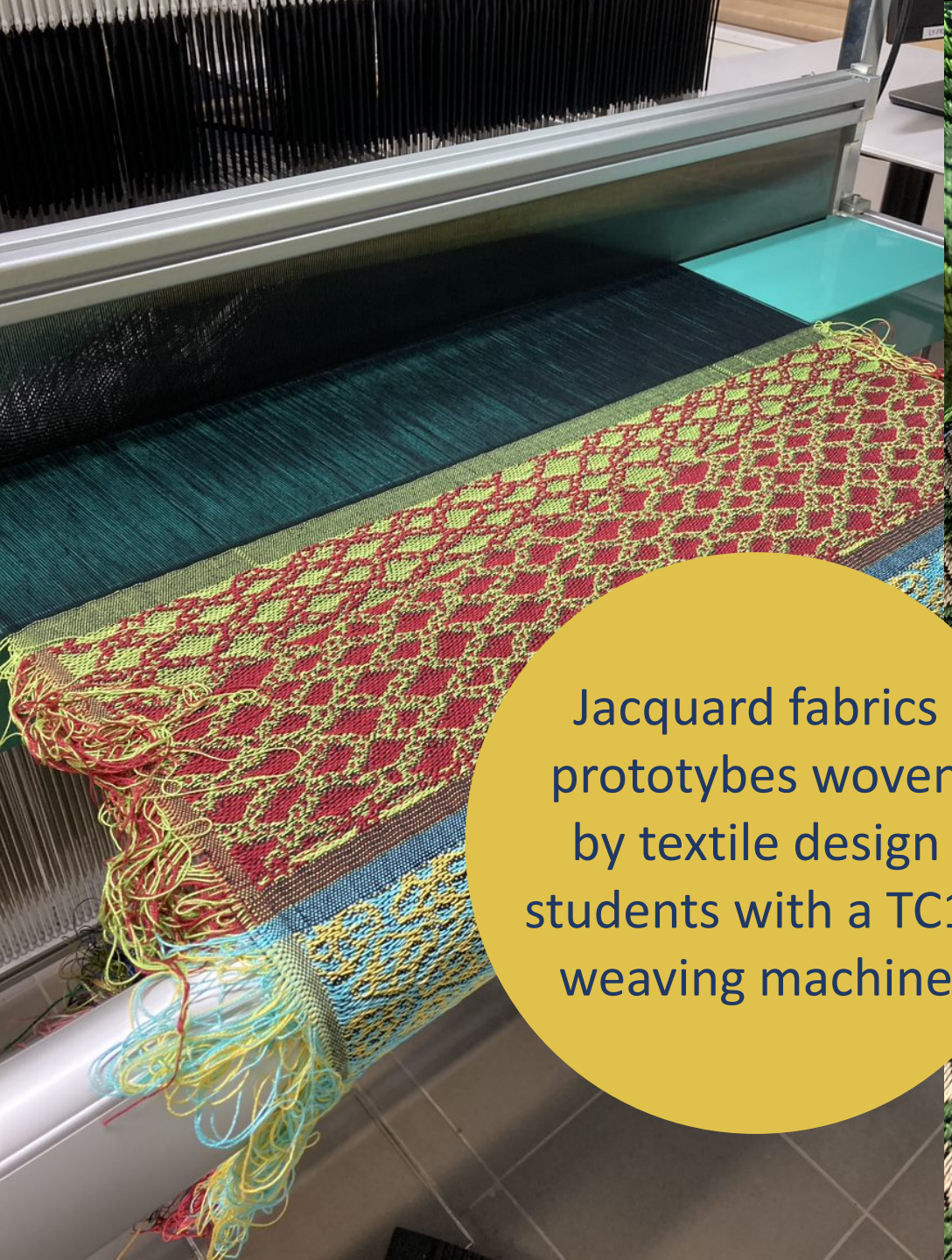
The production plans of the prototypes were created in co-operation with SMEs







Pattern designing in the textile design course at the University of Lapland







Jacquard fabrics prototybes woven by textile design students with a TC1-weaving machine


Textile design
workshop at Annala Oy





Weaving jacquard fabrics with industrial weaving machine and designing of color variations



Finished fabrics in
different color variations:

Laineet, Fanni Tamminen
Tvåtiti, Tiina Lamminen
Virta, Kirsi Eskelinen


Arctic Fashion Show
in Rovaniemi


The project considered ways to repel mosquitoes without chemicals, with the help of colors

Vipuvoimaa EU:lta 2014–2020

Future Bio-Arctic Design

Euroopan unioni
Euroopan aluekehitysrahasto

ANNALA

KNITECO
Plant The Idea

OOOZA DESIGN

JAATU
HANDMADE IN IVALO

In co-operation

HEMPEA

KAAMOSKEHRÄ
OSUUSKUNTA

FLUFF STUFF

Värisävy Oy

LAPIN YLIOPISTO
UNIVERSITY OF LAPLAND

Luke
LUONNONVARAKESKUS

LAPIN AMK
Lapland University of Applied Sciences

Ammattiopisto Lappia

Arctic Warriors Oy

Arktiset Aromit - Arktiska Aromer ry

Fluff Stuff Oy

4H Oulu

4H Salla

Huovisenniemen metsätila

Holstila Arctic Nature Power

Isontuvan jäätelö Oy

Joutsen Finland Oy

Järvi Z Oy (Havue Collection)

Kentalan luomutila



Keskitalon luomutila (Lähisuomi Oy)

N63 Herbs osk

Nordicforyou.fi

Nordic Herbs Oy

Repojotos (Repovesikeskus)

Tmi Anneli Kuhmonen

Tmi Pasmajärvi MLH

Väkipuu tmi

Wild from Arctic

Youngfour Oy

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LUONNONVARAKESKUS

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