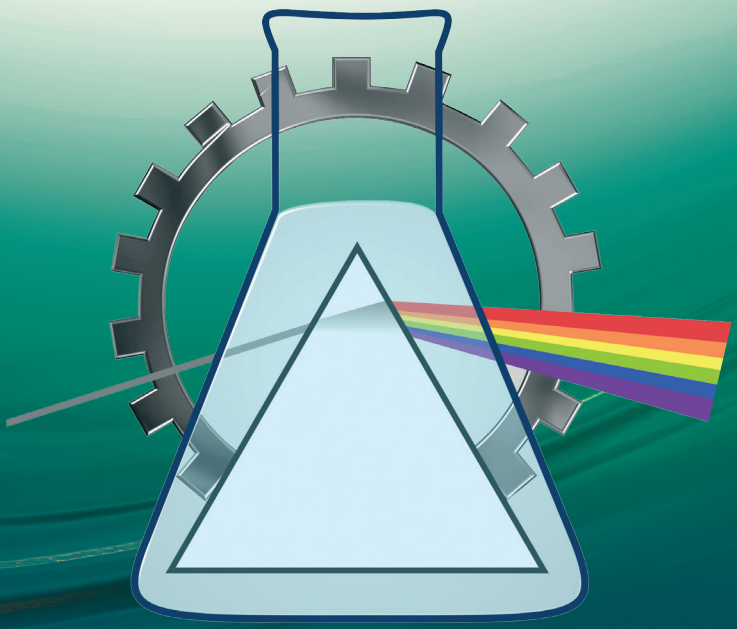
Maria Curie-Sklodowska University
Faculty of Chemistry

UMCS
UNIWERSYTET MARII CURIE-SKŁODOWSKIEJ

# SCIENCE AND INDUSTRY
## challenges and opportunities



WYDAWNICTWO UNIWERSYTETU MARII CURIE-SKŁODOWSKIEJ

**Maria Curie-Sklodowska University**
**Faculty of Chemistry**

# SCIENCE AND INDUSTRY
## challenges and opportunities

**Edited by:**
**prof. dr hab. Zbigniew Hubicki**

WYDAWNICTWO UNIWERSYTETU MARII CURIE-SKŁODOWSKIEJ
LUBLIN 2024

**Reviewers:**
Prof. dr hab. inż. Zygmunt Gontarz
Dr hab. Agata Jakóbik-Kolon, prof. PŚ
Dr hab. Monika Kalinowska, prof. PB
Dr hab. inż. Łukasz Klapiszewski, prof. PP
Dr hab. Joanna Kluczka, prof. PŚ
Dr hab. inż. Agnieszka Kołodziejczak-Radzimska
Dr hab. Urszula Kotowska
Prof. dr hab. Włodzimierz Lewandowski
Prof. dr hab. Joanna Matysiak
Dr hab. Piotr Nowicki, prof. UAM
Dr hab. inż. Magdalena Regel-Rosocka, prof. PP
Dr hab. inż. Katarzyna Siwińska-Ciesielczyk, prof. PP
Dr hab. inż. Katarzyna Staszak
Dr hab. Renata Świsłocka, prof. PB
Dr hab. inż. Karolina Wieszczycka, prof. PP
Prof. dr hab. Leszek Wachowski

**Technical editing, typesetting and proofreading:**
Dr hab. Monika Wawrzkiewicz, prof. UMCS



ISBN 978-83-227-9805-8

PUBLISHED BY WYDAWNICTWO UNIWERSYTETU MARII CURIE-SKŁODOWSKIEJ
20-031 Lublin, ul. Idziego Radziszewskiego 11
tel. (81) 537-53-04
www.wydawnictwo.umcs.eu
e-mail: sekretariat@wydawnictwo.umcs.lublin.pl

SALES DEPARTMENT:
tel./faks 81 537-53-02
Internet Bookstore: https://wydawnictwo.umcs.eu
e-mail: wydawnictwo@umcs.eu

Dear Sirs!

We are handing over to you the monograph “Science and industry - challenges and opportunities”, which is a continuation of the monograph “Science and industry - spectroscopic methods in practice, new challenges and opportunities”. It presents ongoing scientific research. The topics presented in its pages will help to disseminate information on research conducted by your scientific and research centers. We hope that it will contribute to the dissemination of knowledge transfer and new technologies being developed. It is in the interest of each university and research institute to establish an understanding and develop common areas of cooperation. Undoubtedly, these are mutually beneficial, both to scientists through integration with the economic and social environment, and to entrepreneurs adapting to changing market conditions. The joint implementation of utilitarian projects, the results of which can find application in industry, stimulates scientists to direct their activities towards the most desirable research topics. Universities and research units thus become a catalyst for economic development. Industry, on the other hand, thanks to such cooperation, gains access to the latest knowledge on the achievements of a given scientific field, supplemented by the knowledge and research experience of scientific partners. Undoubtedly, this cooperation is mutually beneficial. It is also associated with a number of challenges.

To meet the above expectations, we are pleased to present this monograph.

I wish you a fruitful reading experience!
Zbigniew Hubicki

## TABLE OF CONTENTS

# ANTIIFLAMMATORY ACTIVITY OF *PINUS* SP. ISOLATES

**A. ŽUGIĆ[1], S. MIRKOVIĆ[2], M. TOMOVIĆ[3], M. ANĐIĆ[3], A. PETROVIĆ[3], I. NEŠIĆ[4], V.M. TADIĆ[1]**, [1]Institute for Medicinal Plants Research "Dr. Josif Pančić", 11000 Belgrade, Serbia, [2]PHI Hospital "Sveti Vračevi", Bijeljina, Bosnia and Herzegovina, [3]Faculty of Medical Sciences, University of Kragujevac, Department of Pharmacy, 34000 Kragujevac, Serbia, [4]University of Niš, Faculty of Medicine, Department of Pharmacy, 18000 Niš, Serbia.

**Introduction:** Although topical preparations made from various *Pinus* species have ethnotherapeutic use in the treatment of various skin diseases (eczema, acne, alopecia, psoriasis, fungal diseases) and wound healing, the literature to confirm their potential for use in topical products are scarce. Therefore, in an attempt to develop a product based on natural ingredients for potential local treatment of inflammatory skin conditions, *in vivo* antiinflammatory activity of isolates of *Pinus* sp. green cones (essential oil, EO and the extract, E) prior to and after incorporation into liposomes was evaluated.

**Experimental:** EO was isolated from the crushed plant material by steam distillation using a Clevenger apparatus, while E was obtained *via* Soxhlet apparatus using 70% (v/v) ethanol. Four liposomal dispersions were prepared using purified water and Phosal 40 IP (Lipoid, Germany): blank dispersion (sample L), dispersion with encapsulated EO (sample L-EO), blank dispersion with the addition of E in the outer phase (sample L-E) and with encapsulated EO (sample LEO-E). Zetasizer Lab Blue Label was used for liposome size and zeta potential evaluation, while measurements of pH and electrical conductivity were performed using pH-meter HI 9321 and conductometer CDM 230, respectively. In order to check the preliminary physico-chemical stability of the prepared samples, measurements of pH, electrical conductivity, liposome size, and zeta potential were re-evaluated after 30 and 90 days of room temperature storage. The potential anti-inflammatory effects of the examined EO, E, and liposomal dispersions were evaluated *in vivo* using the carrageenan-induced rat paw edema test. Paw edema was induced in a left hind paw of each rat by intraplantar injection of 500 μl of 1% carrageenan (1). All rats were randomly divided into the following groups, depending of applied formulations: L, L-EO, L-E, LEO-E, EOP (water with E and EO), E (water with E), PE (water with E and Polysorbate 20), P (water with Polysorbate 20), HC (hydrocortisone as a standard), CTRL (control, untreated group). Examined formulations were administered topically, 60 min before the carrageenan injection, in an amount of 0.3 g and gently rubbed 50 times with the index finger. To quantify the anti-inflammatory effect, the thickness of the left paw tissue of rats was measured at specific time intervals: immediately before inducing inflammation (moment 0), and 1, 2, 3, and 4 hours after inflammation (moments 1, 2, 3, and 4). The tissue thickness was measured in the middle of the rat paw using a digital caliper and the percentage of inhibition of paw edema was calculated according to the formula.

**Results:** The droplet size of the prepared liposomes was in the range of 197.4 to 250 nm. The average droplet size in the sample L was 217.0. The addition of EO led to a decrease in droplet size, while the addition of E had an inverse effect. In all samples, the

polydispersity index, as a measure of droplet size distribution uniformity was lower than 0.2 indicating that the liposomes were relatively monodisperse. The zeta potential of tested liposomes ranged from – 36.63 to -41.16 mV, suggesting good kinetic stability. pH from 4.0 to 5.01 in all tested samples indicated their applicability in skin products. The addition of EO led to the decrease of conductivity compared to the sample L, while the addition of E led to its increase. Repeated measurements of tested physicochemical characteristics of the investigated liposomes did not change applicability, suggesting satisfactory preliminary stability.

The administration of LEO, LEOE, and LE led to significant inhibition of paw edema compared to the control group. The most significant reduction in edema was observed after the third and fourth hour. Hydrocortisone as a standard anti-inflammatory drug showed the most pronounced degree of inhibition compared to the control group. However, in the fourth hour, the LE and LEOE exhibited a similar effect as this standard drug with a percentage inhibition ranging from approximately 69% to 87%. Considering that LEO, LEOE, and LE exhibited the most prominent effects during the later phase of carrageenan-induced inflammation, we may hypothesize that these formulations affect the release of arachidonate metabolites, possibly by modulating the activity of cyclooxygenase 1 and 2 (2).

**Conclusions:** In the present study, liposomes with EO and E isolated from green cones of *Pinus* sp. revealed satisfactory physico-chemical characteristics/stability, and anti-inflammatory activity suggesting their prospective usage in the preparation of the products based on natural ingredients for potential local treatment of inflammatory skin conditions.

**Acknowledgements:** This study was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, (grant number 451-03-66/2024-03/200003. and NATBIOPREP Eureka E117236).

**References:**

1. N. Nedeljković, M. Nikolić, P. Čanović, M. Zarić, R. Živković Zarić, J. Bošković, M. Vesović, J. Bradić, M. Anđić, A. Kočović, M. Nikolić, V. Jakovljević, Z. Vujić, V. Dobričić, Pharmaceutics, 16 (2023), doi: 10.3390/pharmaceutics16010001.

2. T Mićović, JS Katanić Stanković, R Bauer, X Nöst, Z Marković, D Milenković, V Jakovljević, M Tomović, J Bradić, D Stešević, D Stojanović, Z Maksimović. Journal of Ethnopharmacology, 293 (2022) 115201.