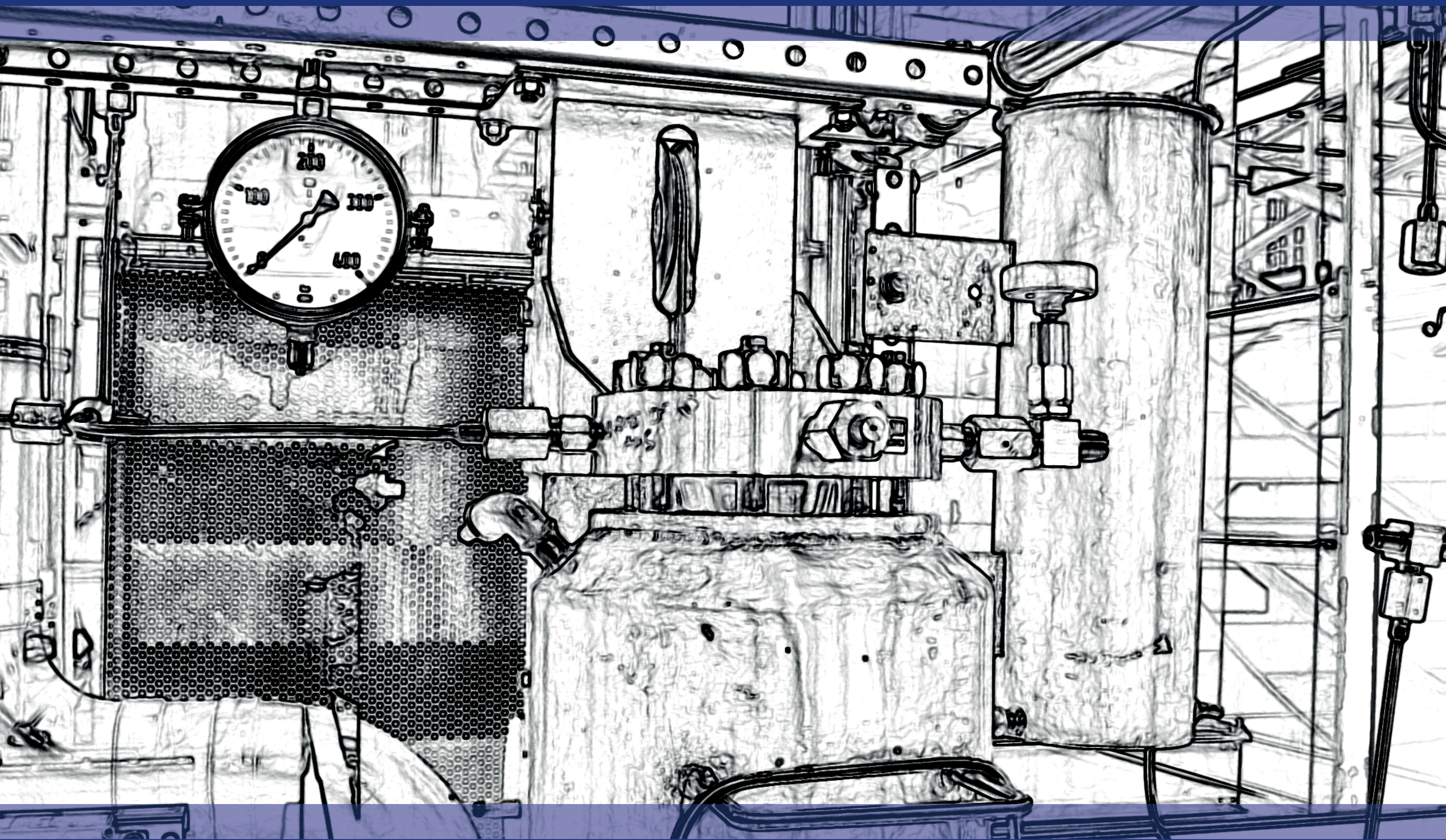
Thomas Gamse, Amra Perva, Zeljko Knez (eds.)

Book of Abstracts

GEHPT and ESS-HPT 2022



Green Engineering by High Pressure Technology

3.7. – 10.7.2022

The European Summer School in High Pressure Technology

11.7. – 17.7.2022

Graz University of Technology

University of Maribor
Faculty of Chemistry and Chemical Engineering

EFCE
European Federation of Chemical Engineering
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Organisation: Thomas Gamse
Institute of Chemical Engineering and Environmental Technology
Graz University of Technology
Inffeldgasse 25/C, A-8010 Graz, Austria
Tel. +43 (0)316 873-7477
E-Mail: thomas.gamse@tugraz.at

Zeljko Knez
Amra Perva
Faculty of Chemistry and Chemical Engineering
Laboratory for Separation Processes
University of Maribor, Smetanova ulica 17, 2000 Maribor, Slovenia
E-Mail: zeljko.knez@um.si; amra.perva@um.si

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Book of Abstracts, GEHPT and ESS-HPT 2022
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Preface

The European Summer School in High Pressure Technology (ESS-HPT) is the continuation of many years of high pressure intensive courses. The history of this very successful series of courses started in 1995, when the first intensive course took place in Monselice, Italy. Most of these Intensive Courses were supported by SOCRATES and later Life Long Learning, as shown in following overview:

SOCRATES IP "Current Trends in High Pressure Technology and Chemical Engineering"

1995 Monselice / Italy
1996 Nancy / France
1997 Erlangen / Germany

SOCRATES IP "High Pressure Technology in Process and Chemical Engineering"

1999 Abano Terme / Italy
2000 Valladolid / Spain
2001 Maribor / Slovenia and Graz / Austria

SOCRATES IP "High Pressure Chemical Engineering Processes: Basics and Applications"

2002 Graz / Austria and Maribor / Slovenia
2003 Budapest / Hungary
2004 Barcelona / Spain

SOCRATES IP "Basics, Developments, Research and Industrial Applications in High Pressure Chemical Engineering Processes"

2005 Prague / Czech Republic
2006 Lisbon / Portugal
2007 Albi / France

Life Long Learning IP "SCF- GSCE: Supercritical Fluids – Green Solvents in Chemical Engineering"

2008 Thessaloniki / Greece
2009 Istanbul / Turkey
2010 Budapest / Hungary

EFCE Intensive Course "High Pressure Technology - From Basics to Industrial Applications"

2011 Belgrade / Serbia

Life Long Learning IP "PIHPT: Process Intensification by High Pressure Technologies – Actual Strategies for Energy and Resources Conservation"

2012 Maribor / Slovenia and Graz / Austria
2013 Darmstadt / Germany
2014 Glasgow / Great Britain

Unfortunately the financial support for these Intensive Programmes was cancelled within ERASMUS+. The EFCE Working Party "High Pressure Technology" decided in September 2014 to go on with this course in the form of a Summer School.

ESS-HPT "The European Summer School in High Pressure Technology"

ESS-HPT 2015	Maribor / Slovenia and Graz / Austria
ESS-HPT 2016	Maribor / Slovenia and Graz / Austria
ESS-HPT 2017	Maribor / Slovenia and Graz / Austria
ESS-HPT 2018	Maribor / Slovenia and Graz / Austria
ESS-HPT 2019	Maribor / Slovenia and Graz / Austria
ESS-HPT 2021	Online Course, Graz / Austria
GEHPT and ESS-HPT 2022	Maribor / Slovenia and Graz / Austria

The ESS-HPT takes place every year within the first 2 weeks of July at University of Maribor, Slovenia and Graz University of Technology, Austria.

This year the first week in Maribor / Slovenia is organised as a COST training school “GEHPT – Green Engineering by High Pressure Technology”, financed by the COST action “GREENERING -Green Chemical Engineering Network towards upscaling sustainable processes”, COST action CA18224.

All participants have to give an oral presentation and the abstracts of these presentations, which are peer-reviewed by the EFCE WP Members, are published in this book of abstracts.

The editor

Thomas Gamse
Organiser of GEHPT and ESS-HPT 2022

Many thanks to our sponsors, COST action CA18224 “GREENERING”, NATEX Prozesstechnologie GesmbH and Tourismusverband Stadt Graz.

Contents

Abstracts of Participants Presentations

	Monday, 4 July 2022		
1	15:30 - 15:45	**Beatriz G. Bernardes, Sara Baptita-Silva, Carlos Illanes-Bordomás, Rui Magalhães, Raquel Costa, Carlos A. García-Gonzaléz, Ana Leite Oliveira** Development of self-assembled aerogel silk particles for wound healing	1
2	15:45 - 16:00	**Nicola Schreiner, Lena Gockel, Markus Busch** High-Pressure Polymerization of Ethylene: From Tubular Reactors, Autoclaves and the Urge to Design a Multi-Zone Autoclave on Laboratory Scale	6
3	16:00 - 16:15	**Maira I. Chinchilla, Fidel A. Mato, Ángel Martín, María D. Bermejo** Hydrothermal CO_2 Reduction by Glucose as Reducing Agent and Metals and Metal Oxides as Catalysts	10
4	16:25 - 16:40	**Jonas Degenkolb, Markus Busch** Investigation of Boundary Layers in Mini-Plant LDPE Tubular Reactors	15
5	16:40 - 16:55	**Marta M Duarte, Rui Morais, Ana Leite Oliveira** Unravelling the Potential of Marine Microalga Porphyridium Cruentum for Wound Healing and Regeneration	18
6	16:55 - 17:10	**Ahmed Elrashidy** Supercritical Solvent Impregnation of Starch Xero- and Aerogels with Carnosic Acid	24
7	17:15 - 17:30	**Denise Eryildirim, Markus Busch** How Methoxyphenol Effects the High-Pressure Polyethylene Polymerization	27
8	17:30 - 17:45	**Joline Hansen** Application of Acoustic Levitation for the Investigation of Hydrogels	30
9	17:45 - 18:00	**Lorenci Gjurgjaj, Elva Duro, Jeta Lica, Mariza Andoni, Aurel Nuro, Altin Mele** Comparison of the Extracts of Albanian Sage and Lavender Gained Using Different Solvents and Techniques	35
10	18:00 - 18:15	**Lara Gibowsky** Investigation of the Packing Properties of Non-Spherical, Nanoporous Deformable Gel Particles During Supercritical Drying	41

	Tuesday, 5 July 2022		
11	17:15 - 17:30	**Laura Euler Bueno, Robin Dursun, Markus Busch, Jan Duchateau** Propargyl Methacrylate - A Bifunctional Comonomer in the High Pressure Polymerization of Ethene	44
12	17:30 - 17:45	**Jeta Lica, Lorenci Gjurgjaj, Iris Çaçani, Carla Ferreri, Altin Mele** The Fatty Acid Analysis of Vitex Agnus Castus Extracts Obtained by Liquid CO_2	48
13	17:45 - 18:00	**Enkeledo Menalla, Maria Jose Cocero** Understanding the Role of Sub/Supercritical Water in the Hydrolysis of the Ester Link in Polyesters	53
14	18:00 - 18:15	**Lena Gockel, Markus Busch** Influence of Mixing on the Initiator Efficiency in High-Pressure Polymerization Reactors	56
15	18:15 - 18:30	**Vid Ravnik, Marko Jukić, Urban Bren** Inverse Molecular Docking of Cannabinoids	59

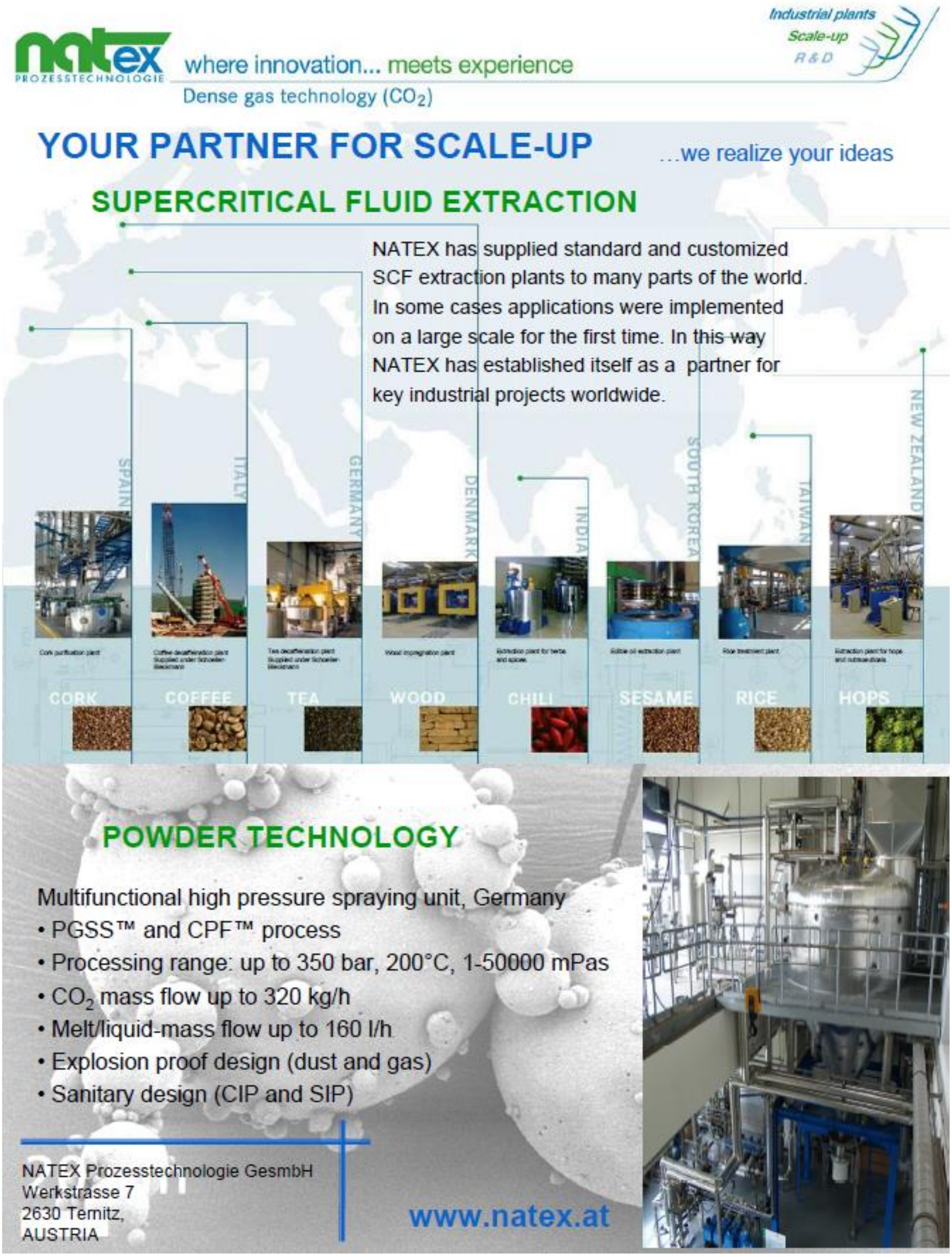
	Wednesday, 6 July 2022		
16	15:30 - 15:45	**Moritz Imhoff, Markus Busch** Ventilated Deflagrations of Polymerization Mixtures	64
17	15:45 - 16:00	**Elisa Mialich** Optimization of $scCO_2$ Drying of Tuna Fillets	68
18	16:00 - 16:15	**Alexander Klimeck, Markus Busch** Group Contribution Method for Transfer Activity in the LDPE Process	73
19	16:25 - 16:40	**Altin Mele, Jeta Lica, Lorenci Gjurgjaj, Dorina Mele, Ardita Mele** Presentation of P,V,T,x Phase Equilibria on Mole Volume – Composition Diagram in the Example of the CO_2 – C_2H_5OH System	76
20	16:40 - 16:55	**Julija Strunčnik** Solvent Absorption Study of Cross-Linked Polymers	81
21	16:55 - 17:10	**Isabel M. Kronshorst, Laura Ständecke, Julia Eigenseer, Markus Busch** A Mini-Plant as a Tool for Understanding the Solution Polymerisation Process	84

22	17:15 - 17:30	**Zala Štukovnik, Urban Bren** Development and Optimization of an Electrochemical-Impedimetric Biosensor Based on Whole Cells for the Detection of Active Compounds	87
23	17:30 - 17:45	**Ka Loi Lin, Thomas Ernst Müller** CO_2 and Biomass as Feedstock for the Production of Chemical Intermediates	92
24	17:45 - 18:00	**Patience Nnenna Abugu** Nano-Silica Grafting with Aminosilanes in Supercritical Carbon Dioxide for Polymer Nanocomposites Preparation	96
25	18:00 - 18:15	**Dennis Panke, Thomas E. Müller** Conversion of Lignin to Phenolic Base Chemicals	102

	Thursday, 7 July 2022		
26	17:15 - 17:30	**Aaron Röblitz, Markus Busch** Visualization of Relief and Decomposition Phenomena in High-Pressure Systems	106
27	17:30 - 17:45	**Alina Satpayeva, Juan Garcia-Serna, Danilo Cantero** Evaluation of Chemical Reaction of Biomass under Partial Oxidation in Supercritical Water	110
28	17:45 - 18:00	**Lorenz Schmidt, Markus Busch** Influence of Initiators on Temperature Distribution in High-Pressure Polyethylene Autoclaves	113
29	18:00 - 18:15	**Inês Vasconcelos Silva, Raquel Costa, Ana Leite Oliveira** Using Supercritical Carbon Dioxide to Process Biological Tissue into Preserved and Highly Functional Matrices for Tissue Healing and Regeneration	117
30	18:15 - 18:30	**Azra Osmić, Matjaž Finšgar, Gal Slaček, Taja Žitek, Maša Knez Marevci, Željko Knez** Extraction of Active Components from Cranberry (Vaccinium vitis-ideaea) and Determination of Antimicrobial Potential	124

Registered Lecturers 130

Registered Participants 132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Development of self-assembled aerogel silk particles for wound healing

Beatriz G. Bernardes[1,2], Sara Baptita-Silva[1], Carlos Illanes-Bordomás[2], Rui Magalhães[1], Raquel Costa[*3,4,5], Carlos A. García-Gonzaléz[*2], Ana Leite Oliveira[*1]

[1] Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Porto, Portugal

[2] Department of Pharmacology, Pharmacy and Pharmaceutical Technology, I+D Farma group (GI-1645), iMATUS and Health Research Institute of Santiago de Compostela (IDIS), Universidade de Santiago de Compostela, E-15782 Santiago de Compostela, Spain

[3] Instituto de Investigação e Inovação em Saúde, Universidade do Porto (i3S), Porto, Portugal

[4] Department of Biomedicine, Biochemistry Unit, Faculdade de Medicina, Universidade do Porto, Porto, Portugal

[5] Escola Superior de Saúde, Instituto Politécnico do Porto, Porto, Portugal

*raquel.costa@i3s.up.pt; carlos.garcia@usc.es; aloliveira@ucp.pt

Introduction

Chronic wounds are one of the major therapeutic and healthcare challenges. The wound healing process is divided in three important stages (haemostasis, inflammation and proliferation/maturation) that deploy a series of biochemical reactions which induce the repair of the injury. In chronic wounds, healing is prolonged in the inflammatory phase without reaching the required anatomic and functional integrity to attain the proliferation phase.[1] A fluid (exudate) can be produced as a natural response towards healing. However, its excessive production can be detrimental, as it promotes bacterial growth, delaying the inflammatory phase. Nowadays, the design and development of biocompatible, biodegradable and adaptable materials that promote the tissue repair, prevent the infection and inflammation and ensure the management of exudate are a constant need for wound management.

Aerogels are nanostructured materials with high porosity, large surface and low bulk density.[2] They can provide advanced performance for wound healing due to their high porosity and large surface area, which can be tailored for a fast and directional fluid transfer of the exudate. Bio-based aerogels, from natural polymer sources are assessed as drug carriers because of their biocompatibility, biodegradability, low toxicity, high loading capacity, enhanced stability upon storage and tuneable drug release.[3,4] Silk fibroin (SF) protein, obtained from *Bombyx Mori,* is an excellent carrier of bioactive compounds while supporting cell proliferation, being presently used in wound healing and regeneration. In this work, we propose the use supercritical CO_2 technology to develop SF aerogel particles for wound treatment.

Experimental

Silk fibroin extracted from *Bombyx mori* cocoons was used for the aerogel particles' production. Different SF aqueous solutions (3, 5 and 7% (w/v)) were added dropwise to a mixture of ethanol and sorbitan oleate (Span 80) (3 wt.% with respect to SF), followed by supercritical CO_2 drying (120 bar, 39ºC, 3.5 h). SF aerogel particles were characterized concerning particle size distribution by laser diffraction. The average diameter and the dispersion increased with increasing SF concentration. These particles presented also high surface area and low skeletal density (Figure 1A). Fourier Transform Infrared with Attenuated Total Reflectance spectroscopy (FTIR-ATR) was used to study the chemical structure, in particular secondary structure formation. It was possible to verify the presence of the main characteristic bands of SF assigned to the presence of β-sheet structure (Figure 1B). Textural properties were analyzed by helium pycnometry and N2 adsorption-desorption presenting high surface area and low skeletal density.

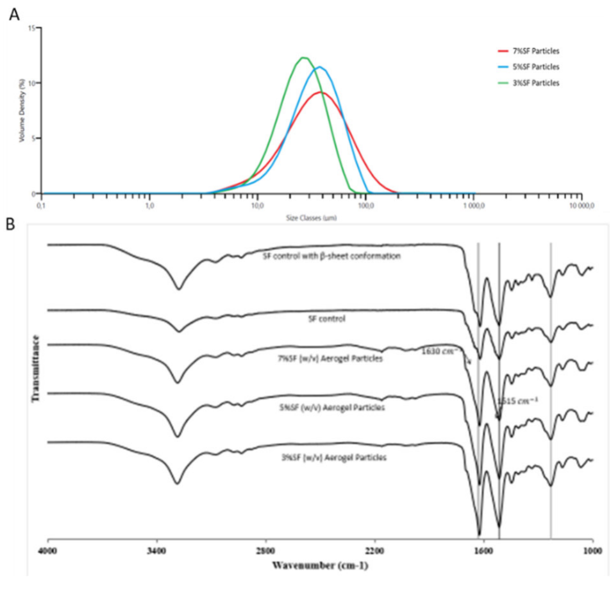

Figure 1 - A) Laser diffraction of different concentrations of S aerogel particles. B) FTIR-ATR of SF aerogel particles and controls of natural SF and SF with β-sheet conformation.

Aerogel particles' biocompatibility was evaluated by direct contact with Human Dermal Fibroblasts (HDF's) and observed by Scanning Electron Microscope (SEM). Figure 2A, represents the SF Aerogel particles by SEM. Quantitative data were subjected to an analysis of variance (one-way ANOVA, Tukey's test; α=0.05. SF aerogel particles were tested by MTT assay and the cell viability increases consistently with time. After 24 h of incubation, all the aerogels presented a cell viability of 50% and there were significant differences between the cells in contact with the aerogel particles and the control group (Figure 2A). This cell response to the presence of aerogel particles, could be related with the initial adaptation of the cells to the contact with the particles. After 48 h, the cell viability increased considerably to 100%, having no significant differences between the control group, demonstrating that the cells were able to adapt to the aerogel particles. After 7 days of incubation, it was possible to verify that the aerogel particles had a marked effect on promoting cell proliferation.

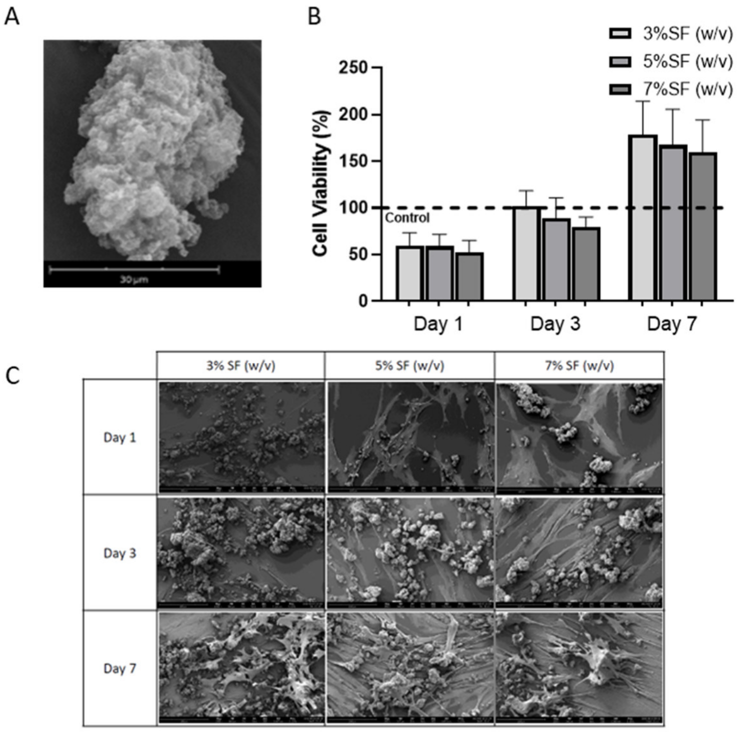

Figure 2 – A) SEM micrographs of SF Aerogel particles. B) Cell viability after MTT assay of control group of NDF's cells and cells cultured with aerogel particles. After Tuckey's analysis of variance there were no statistical difference between groups for the same time point (α < 0.05). C) SEM micrographs of HDF's cell adhesion and culture on the SF Aerogel particles for 1, 3, and 7 days. Magnification of 1050× were used.

Following these promising results, studies are ongoing to use these particles as a controlled release system of adenosine, a nucleoside that is expected to trigger the healing process of chronic wounds, promoting angiogenesis and regeneration.[5]

Summary

Wound exudate is a natural response to heal. However, its excess production can compromise and delay the inflammatory phase, which often is associated with chronicity. Novel biocompatible, biodegradable and adaptable dressings are sought to promote tissue regeneration, prevent infection and control inflammation. Aerogels are nanostructured materials with high porosity, large surface area, low bulk density and water uptake that can provide advanced performance for wound healing, especially considering the management of exudate. Silk fibroin (SF) aerogels can act as promising carriers of bioactive molecules while supporting cell proliferation. Hereupon, SF aerogel particles were developed as carriers for controlled release of bioactive molecules such as adenosine for promoting wound healing and regeneration.

Acknowledgments

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