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RRB 2021 • 6 - 8 September, 2021 • Aveiro, Portugal

RRB 2021

RENEWABLE RESOURCES & BIOREFINERIES

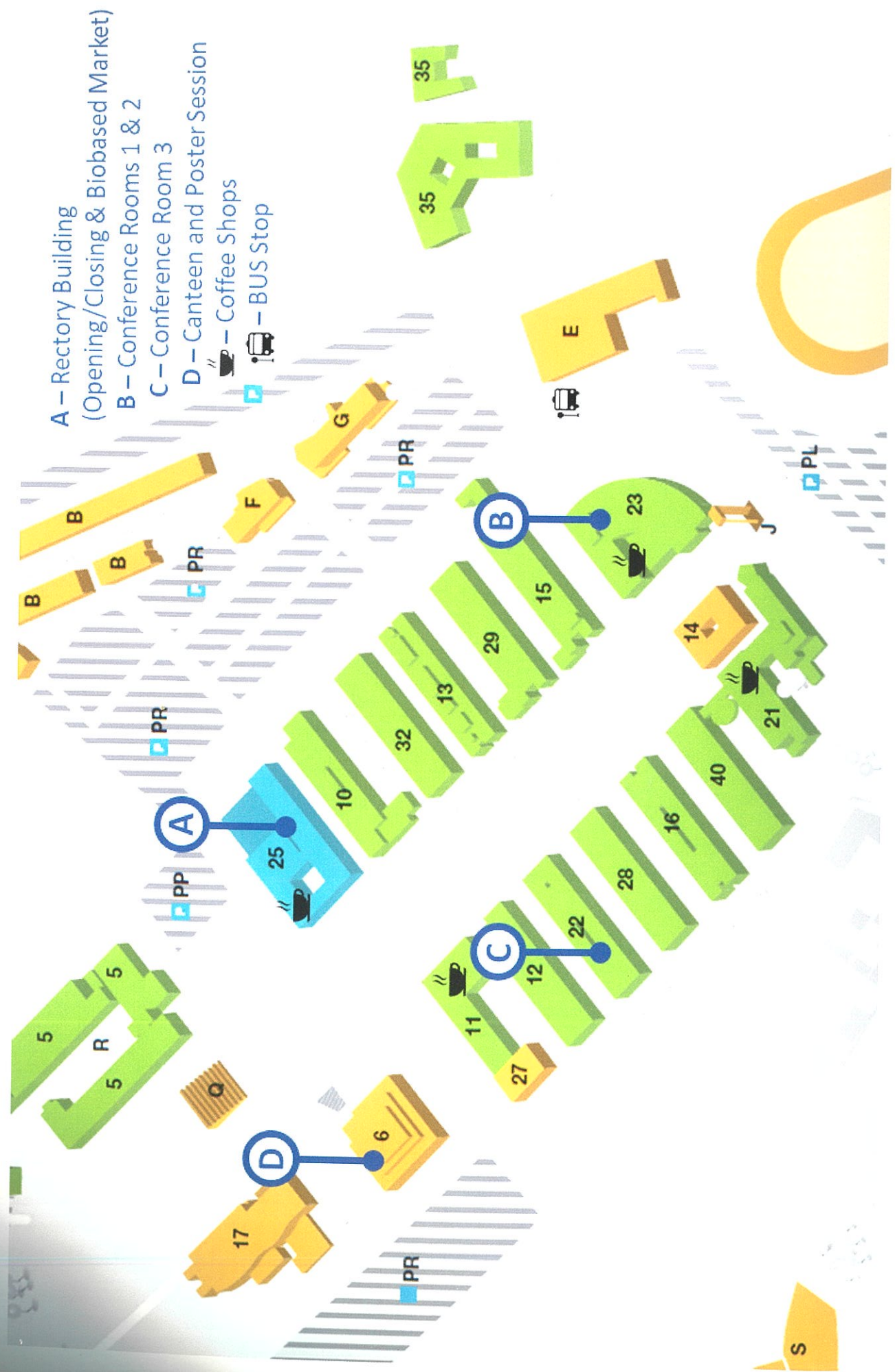
17th International Conference on Renewable Resources and Biorefineries

Biobased solutions for climate change

6 - 8 September 2021 • Aveiro, Portugal

Final Programme & Abstract Book

Map of the Santiago University Campus



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RRB 2021

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Welcome to RRB 2021

Society in general and its consumers, as well as the industrial and agricultural production sectors, are now increasingly convinced that a switch from a fossil based economy towards one that is based on renewable resources has become imminent. This switch is essential to counteract the negative effects of climate change, air pollution, waste accumulation, dwindling fossil resources, and unreliable energy and power supply. In this context, sustainable development is crucial for the wellbeing of the next generations. Striving towards establishing a circular or reuse economy, increasingly based on using renewable resources, is a challenge for society, with science and technology being important to provide solutions. Interdisciplinary teams of scientists, engineers, biotechnologists and policymakers have to collaborate more intensively to adequately deal with these challenges.

Our series of RRB-conferences (now in its 17th edition) offer such an opportunity. Delegates from university, industry, governmental and non-governmental organizations will present their research and views on sustainable (green) chemistry, industrial biotechnology and on agricultural policy related to the use of renewable raw materials for non-food applications and energy supply. This will be presented in plenary and oral presentation sessions and poster tours. New research concepts but also new policies related to the circular bio-economy and the sustainable production of biochemicals and bio-materials will be discussed and exchanged with several industrial companies and vice versa.

The conference programme is organized in 3 parallel sessions and includes 2 keynote lectures, 13 invited lectures and 71 high quality oral presentations by international experts and PhD students, covering both scientific, technical and policy aspects of the bio-based economy.

From 6 to 8 September 2021, Aveiro, Portugal will host the 17th edition of the **International Conference on Renewable Resources and Biorefineries (RRB 2021)**.

We hope that this specialist forum for renewable resources, green chemistry, industrial biotechnology, and biorefineries will stimulate the transition from a fossil-based to a bio-based economy.

The sessions deal with these topics:

- Biobased and biodegradable materials
- Biocatalysis
- Bioenergy
- Biorefining
- Chemical platform molecules
- CO_2 capture and utilisation
- Food and agricultural wastes
- Horizon 2020/Horizon Europe
- Marine bio-economy
- Novel fermentation processes
- Nutrient recycling
- Polysaccharides
- Sustainability analysis
- Wood and forestry

Information on the preceding conferences can be found at: https://rrbconference.com/programme-previous-editions/

We wish you an instructive Conference and a pleasant stay in Aveiro!

The RRB 2021 Organizing Committee

Prof. Christian Stevens
Prof. Wim Soetaert
Ir. Philippe Tavernier
Em. Prof. Erick Vandamme
Prof. Ana Xavier
Prof. Luisa Serafim
Prof. Dmitry Evtyugin

ESSENTIAL OIL FROM HEMP FLOWERS: A HIGH-VALUE DERIVATIVE FROM A CULTIVATION BY-PRODUCT

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Cannabis sativa L. is an annual herb cultivated since ancient times for different purposes. While in the past hemp inflorescences were considered crop residues, today they are employed for the extraction of their essential oil (EO), which has gained an increasing interest thanks to its several activities in different fields of application. The aim of the present study was the evaluation of the yield and the chemical composition of the EO obtained by hydrodistillation from eleven hemp cultivars, cultivated for two consecutive years. The EO composition was analyzed by GC-MS, and then subjected to multivariate statistical analysis. Sesquiterpenes represented the main class of compounds in all the EOs, both in their hydrocarbon and oxygenated forms, with relative abundances ranging from 47.1% and 78.5%; the only exception was the 2019 Felina 32 sample, in which cannabinoids predominated. Cannabinoids were also present, with relative abundances between 11.8 and 51.5%, with cannabidiol as the main compound of this class. The statistical distribution of the samples, performed on the complete chemical composition of the EOs, evidenced a partition based on the year of cultivation, rather than on the cultivar, with the only exception of USO-31. Regarding the EO yield, a significant variation was evidenced among both the cultivars and the years of cultivation.

EXPLOITING GREEN SOLVENTS FOR THE VALORIZATION OF CHESTNUT SHELL WASTE

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The full utilization of agricultural waste and its recycle into a new chain of value are of primary importance for the development of a sustainable and profitable agricultural industry. In this context, the study aims at exploring the complete valorization of chestnut shell waste (CSW), obtaining both high value-added compounds and enriched cellulose and lignin fractions. The results were obtained by a combined use of two classes of green and nonconventional organic solvents, namely natural deep eutectic solvents (NADESs) and bio-based ionic liquids (bio-ILs). At first, combinations of choline chloride (ChCl)-based DESs with an acid, a polyol, or a sugar as hydrogen bond donors were employed for the extraction of polyphenols from the CSW. The composition of the extracts was ascertained by high performance liquid chromatography analysis and the polyphenols content was assessed by colorimetric assays. The extraction efficiencies of the DESs tested correlate well with the measured Kamlet–Taft α parameters. Subsequently, a microwave assisted process (a fast, cheap and more sustainable approach) was developed and optimized for the polyphenols extraction using the best performing system, ChCl:oxalic acid dihydrate (ChCl:Oax2H_2O) which showed a remarkable affinity to MW heating. After polyphenol removal, the residual solid material was treated with a bio-IL [cholinium glycinate (ChGly)] for further separation of lignin and cellulose. The products obtained by the fractionation process were characterized by Fourier transform infrared spectroscopy and thermogravimetric analysis, which confirmed the separation of the residue into a lignin-rich material and a cellulose-rich material. The results obtained were further corroborated by a three parallel reaction model combined with the distributed activation energy model, which allowed for predicting the composition of the pristine CSW and of the ChCl:Oax2H_2O treated CSW as well as the two fractions obtained after ChGly treatment. The recyclability of the best performing DES and the recovery of the bio-IL have also been proven, which make the whole process viable and amenable for large-scale applications.

XYLANASES PRODUCTION BY NOVEL *CELLULOMONAS* STRAINS USING LIGNOCELLULOSIC RESIDUES

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Polysaccharide degrading enzymes play a crucial role in many industrial bioprocesses and have a huge potential to be applied in future advanced technologies and biorefineries utilizing lignocellulosic raw materials. Thus, the cost-effective production of efficient cellulase and hemicellulase enzymes is of great importance. Recently, there has been a growing research interest in bacterial enzyme production using low-cost, widely available raw materials of lignocellulosic restudies. Bacteria belonging to the *Cellulomonas* genus are promising candidates due to their great ability to secrete multiple polysaccharide degrading enzymes during their cultivation on different lignocellulosic residues.

Three species of *Cellulomonas*, namely *Cellulomonas* sp. B6, *C. fimi*, and *C. phragmiteti*, were investigated in this study with the main focus on their xylanases production induced by the growth on different model substrates (e.g. carboxymethyl cellulose, solka-floc) and lignocellulosic residues (e.g. wheat bran, waste paper, corn cob, brewer's spent grain, rice straw, press cake of green biomass) during submerged aerobic cultivation. Characterization of the produced enzyme activities, scale-up of the enzyme production and application of the produced enzyme extracts in biomass hydrolysis were also investigated.

Waste paper was found to be a good inducer for xylanases production by *C. fimi.* and *C. phragmiteti*, while in the case of *Cellulomonas* sp. B6, the highest xylanase activity was obtained on wheat bran. Enzyme productions in bench-scale bioreactor were successfully accomplished on the selected feedstocks. Biomass hydrolysis experiments on extruded barely straw using the produced enzyme extracts resulted in efficient liberation of xylose and xylo-oligosaccharides.

Xylanases production by using bacteria belonging to the *Cellulomonas* genus and lignocellulosic residues as raw materials is proved to be a promising method in respect of lignocellulosic bioprocesses and biorefineries.

CONCENTRATION OF NATURAL DYES DERIVED FROM *RUBIA TINCTORUM* L. AND *RESEDA LUTEOLA*, BY NANOFILTRATION AND THEIR EVALUATION AS A BIOREFINERY FEEDSTOCK

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In Europe, between 2007 and 2011, natural dyes market (39%) exceeded the one for synthetic dyes (37%), highlighting allergic aspects of certain synthetic dyes influencing consumer choice. As such, the use of natural dyes in the textile / cosmetics / leather / paints area, etc., has potential to thrive. Dying plants such as *Rubia tinctorum* L. and *Reseda luteola*, are grown specifically for natural dyes production. Although the main issue is the dye production, great part of the plant is not valorized or is simple applied as soil fertilizer.

The present work focuses on the production and extraction of natural dyes. This typically implies the use of great amount of solvents, obtaining extracts with low dye concentration, leading to a higher quantity of extract to obtain the same result as with synthetic dyes. From that, it is clear that concentration of produced extracts could present economic and environmental advantages. Based on this, within this work, ethanolic extracts from *R tinctorum* L. and *R. luteola*, were concentrated by membrane separation processes, and the remaining part was characterized according to NREL protocols to evaluate their potential use in the biorefinery.

Operating parameters, such as transmembrane pressure, temperature and membrane polymeric layer material, play an important role on the efficiency of compounds purification by nanofiltration. Duramem 200® was selected as nanofiltration membrane, considering the pigments lutein and apigenin molecular weight. System was operated under total recirculation for transmembrane pressure and compounds rejection. After that, extract concentration was performed at a transmembrane pressure of 20 bar and a recirculation flow of 240 L/h. Results obtained revealed a concentration factor of 3, with a minimum loss of colorant compounds.

Further work, regarding the application and comparison of produced dye and synthetics ones should be performed.