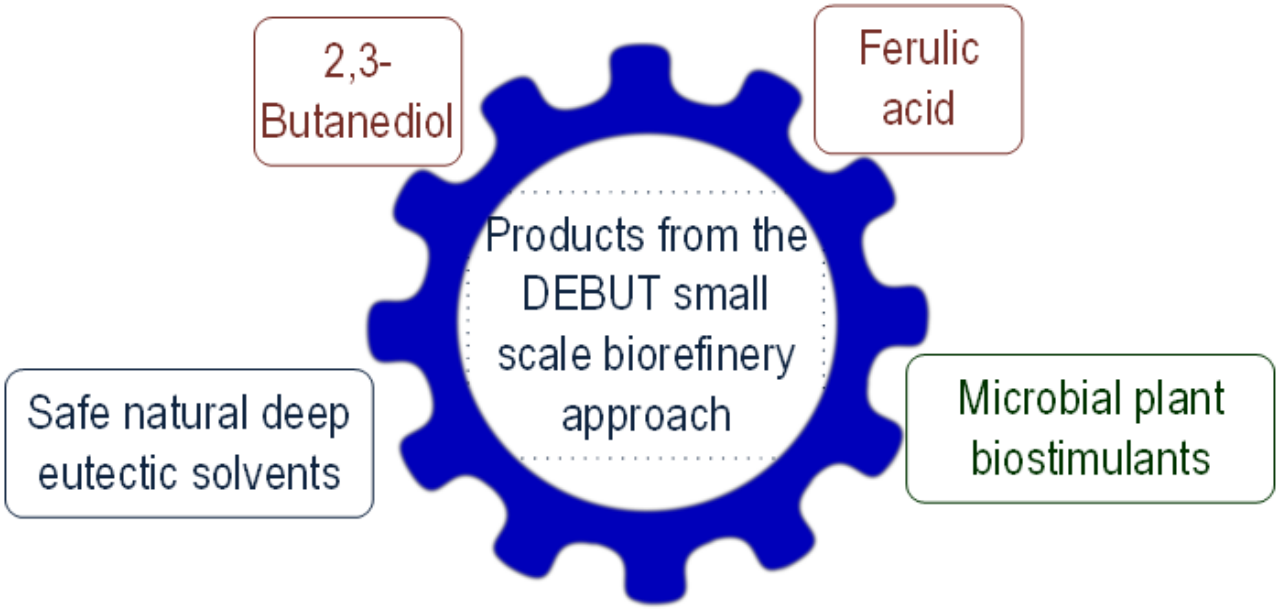
DEBUT

PRODUCTION OF FERULIC ACID, 2,3 BUTANEDIOLE AND MICROBIAL PLANT BIOSTIMULANTS FROM LIG-NOCELLULOSIC BIOMASS BY A TWO-STEP CASCADING PROCESS



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FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

BACKGROUND

LLignocellulose feedstocks have a complex structure, highly recalcitrant, wherein hydrophilic biopolymers, cellulose and hemicellulose, are closely bound to hydrophobic lignin. Feruloylated hemicelluloses are key components of this lignocellulose recalcitrance, anchoring the hydrophobic lignin to hydrophilic polysaccharides. Feruloyl esterase, FAE, (EC 3.1.1.73), is a versatile enzyme for lignocellulose biorefinery, which allows a multi-stage cascading use of biomass, according to the "pyramid value" concept – release ferulic acid and weakening lignocellulose matrix structure. Neoteric solvents, such as deep eutectic solvents, could be used to enhance FAE impacts on lignocellulose recalcitrance. The released sugars could be further utilized for biochemical biorefinery processes. One such biorefinery process is simultaneous saccharification and fermentation (SSF), which has the advantages of lower energy consumption and smaller investment intensity.

OBJECTIVE

The DEBUT project goal was to develop a small scale biorefinery process, which includes two main steps: 1) biomass pretreatment with natural deep eutectic solvents (NaDES) and feruloyl-esterase (FAE); and 2) one-pot production of a versatile chemical, 2,3 butanediol (2,3-BD) from NaDES-FAE pretreated lignocellulose biomass, by simultaneous saccharification and fermentation (SSF), performed by a plant biostimulant microbial consortia. The plant microbial consortia include selected Trichoderma and Bacillus strains.

The objectives of the DEBUT project are:

i) to develop and to assess the NaDES-FAE biomass pretreatment process;
ii) to optimize SSF of pretreated biomass with plant biostimulants microbial consortia and
iii) to test in relevant conditions the demonstration model and the microbial plant biostimulants product.

METHODOLOGY

The project was divided into 7 work packages (WPs), 5 related to achieving scientific project objectives, 2 support work packages, Dissemination and communication, and Management. The scientific workpackages were: WP1 Development of NADES – FAE lignocellulose pretreatment, with ferulic acid recovery; WP2. Safety and eco-efficiency assessment of selected NADESs and extracted ferulic acid; WP3. Optimization of hemicellulose and cellulose SSF with microbial consortia, WP4. Testing and assessment of demonstration model; WP5. Testing microbial plant biostimulants products. The first two WPs were related to the 1st objective, the NaDES-FAE biomass pretreatment process. The 3rd WP was connected to optimizing the SSF of pretreated biomass with plant biostimulants microbial consortia. The last two WPs contribute to the demonstration of the functionality of the DEBUT project's innovative solutions.

RESULTS

Several NaDES were synthesized by combinations of two or three natural compounds and characterized by NMR and FTIR. Toxicity was determined for cultivated plants and biostimulant microbial strains. The pretreatment with aqueous NaDES comprising ChCl: Gly and ChCl:2,3 BD was the most efficient fractionating wheat straw into three major streams: cellulose-rich pulp, lignin, and ferulic acid-rich liquor. The saccharification and fermentation were done in a sequential process. For saccharification and fermentation of the cellulose-rich pulp, a microbial consortium was selected. The selected microbial strains were effective in sequential saccharification and fermentation processes and as microbial plant biostimulants.