FUNDING PROGRAMME: ERANET-COFUND-MANUNET III, PN III, European and International Cooperation
SUBPROGRAME: 3.2 - Horizon 2020

PROJECT TITLE/ACRONYM: Exploiting fungi potential for recalcitrant compounds removal from cellulosic wastewaters - FunCell

CONTRACT NO.: 21/2018

PROJECT TOTAL BUDGET: 3.332.227 Lei (715,500 €) **INCDTP BUDGET**: 454.090 Lei (97,502 €)

START DATE: 1/6/2018 **END DATE:** 1/6/2020

WEBPAGE: https://fluensys.ro/cercetare/proiecte/funcell

PARTENRS:

1. **SC DFR Systems SRL** (**CO** -Romania)

2. **Consorzio CuoioDepur SpA** (Italy)

3. **The National R&D Institute for Textiles and Leather (INCDTP)**(Romania)

4. **Opus automazione spa** (Italy)

5. **Department of Civil and Environmental EngineeringUniversity of Florence** (Italy)

GENERAL OBJECTIVE:

FunCell consists is the development of an innovative mycobased tertiary treatment for tannery and papermill wastewaters efficient in removing tannins and absorbable organic halogen (AOX), not depleted by consolidated bacterial (classic) based processes.

SPECIFIC OBJECTIVES/ EXECUTION PHASES:

Specific objective 1. Isolating a fungal bioactive consortium (bioactivetool). Utilizing cellulose as carbon source capable to transform biodegrade and deplete tannins and AOXs. The capacity of the fungal candidates to exert their metabolic potential utilizing different substrates for growth, comprising cellulose, will be evaluated both in sterile and nonsterile conditions at bench scale.

Specific objective 2. For the scaling up of the experimentation, the selected fungal strain will be grown on innovative polyethylene carriers. The carrier will be designed to be exploited in a moving bed bioreactor and to favor fungal growth in the presence of competing bacteria.

Specific objective 3. Designing and testing a moving bed bioreactor (MBBR) capable of favoring the growth and metabolic activity of the bioactivetool by the exploitation of the innovative carrier in nonsterile conditions where bacteria are usually more competitive.

NOVELTY ELEMENTS/ SCIENTIFIC CONCEPT:

The FunCell project aimed to advance from TRL3 (experimental proof of concept) to TRL6 (validation of a pilot-scale system in a relevant environment), by developing an innovative wastewater treatment technology that integrates fungi (WRF and Ascomycetes) with the MBBR system (Moving Bed Biofilm Reactor). The innovation lies

in the use of a cellulose-based fungal support, which serves both as a carrier medium and as a carbon source, promoting the selective growth of fungi over bacteria. The technology targets the one-step degradation of recalcitrant compounds, such as AOX and tannins, which traditionally require combined aerobic-anaerobic processes for removal. Fungi, which are resistant to tannins and capable of metabolically transforming them, can be used to improve treatment efficiency by leveraging their specific enzymatic capabilities in the treatment of wastewater from the pulp and leather industries.

EXPECTED EXPLOITABLE RESULTS:

R1. A new type of support media (carriers) specifically designed produced and tested to support fungal growth in a not sterile environment typical of wastewater treatment. These carriers will be novel and/or optimized for what concern the geometry, the size, the surface properties and the material and will be a new product for the market of MBBR.

R2. A new bioreactor specifically designed to support fungal growth in a potentially inhibiting environment and when competing for substrates with bacteria.

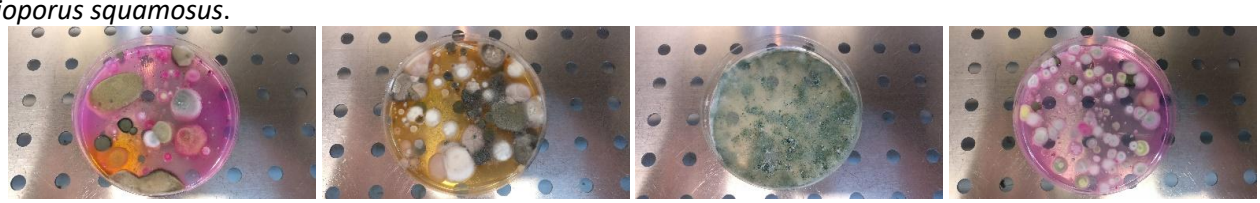
OBTAINED RESULTS:

1. Prospective study on microbial strains (WRF and ASC) involved in wastewater treatment.

Highlighting biotechnological methods used for the removal of pollutants from wastewater and soil through efficient, scalable, and in situ applicable processes. Various biofilm reactor configurations and the use of mobile bio-carriers to support the development of microorganisms involved in treatment were analyzed.

2. Collection of microbial strains from culture collections and isolates from natural wastewater sources

The microbial strains from collections were selected from the phylum Ascomycota: *Trichoderma viride*, *Aspergillus niger*, *Fusarium oxysporum*, *Aspergillus flavus*, and one strain from the phylum Basidiomycota: *Cerioporus squamosus*.



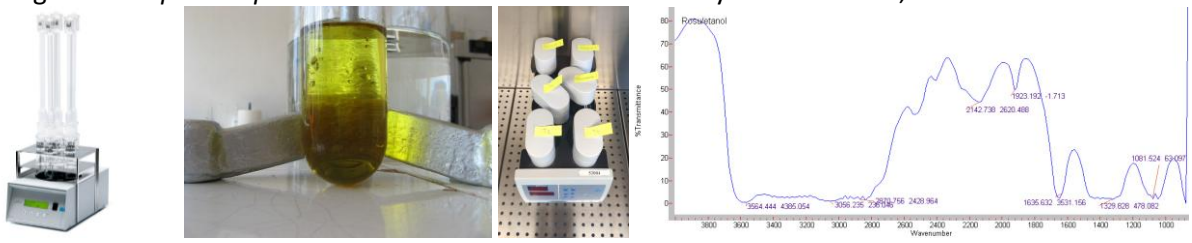
3. Physico-chemical analysis report on wastewater samples containing plant-based tannins

3.1 Chromatographic analysis on wastewater containing 5 plant-based tannins, originating from the leather tanning process flow, conducted at INCDTP, Leather and Rubber Research Division.

3.2 Determination of Chemical Oxygen Demand (COD) – a general indicator of water quality, measuring the capacity to deplete dissolved oxygen in samples contaminated with organic matter.

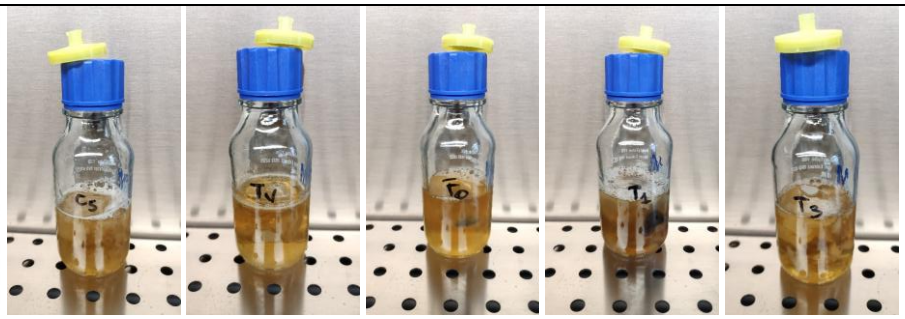
3.3 Determination of Biochemical Oxygen Demand (BOD) – represents the amount of oxygen consumed by microorganisms over a period of time for the biochemical decomposition to mineralization of organic substances present in water.

3.4 FT-IR analysis – FT-IR analysis was performed on the degradation compounds resulting from microbial activity, using the *Cerioporus squamosus* strain on the industrial azo dye Bemacid Rot, from Bezema.



4. Method for cultivating microbial strains at bioreactor scale

As part of the FunCell project, growth experiments were carried out for six microbial isolates in a controlled environment (isolates T1, T2, and T3 from stage 1, plus culture collection strains: *Trichoderma viride, Cerioporus squamosus, Fusarium oxysporum*), using a bioreactor from Applikon Biotechnology (Netherlands), with process data recording, monitoring of temperature variation, pH, oxygen consumption, and a heating system with integrated cooling channel.

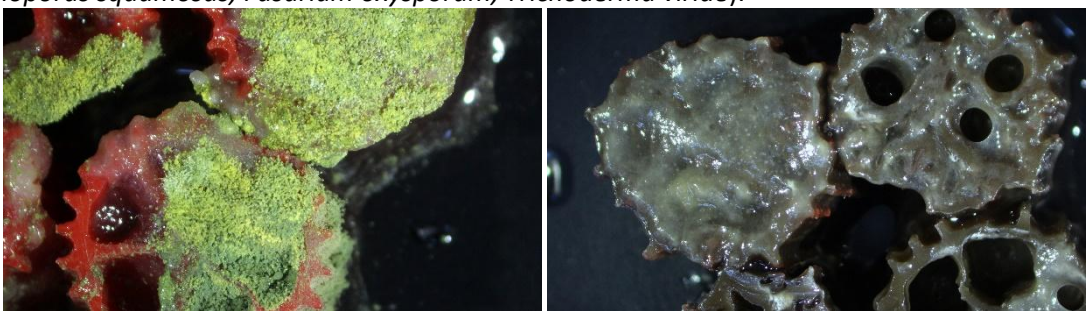



5. Laboratory-scale wastewater treatment installation with polymeric carriers using the MBBR method

Versatile laboratory installation designed to allow bio-augmentation of the polymeric structures (specific to MBBR) developed within the project. The installation was designed and built to enable complete sterilization, including filters, nutrient medium, and carriers.

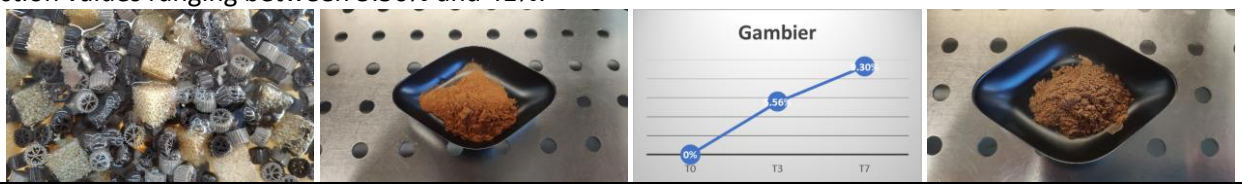
6. Collection of polymeric structures biofunctionalized with microbial strains

Two prototypes of MBBR-specific polymeric structures were obtained (C1: 5% talc + 5% cellulose; C2: 5% talc + 7% cellulose), biofunctionalized with both microbial strains isolated from natural sources and culture collection strains (*Cerioporus squamosus, Fusarium oxysporum, Trichoderma viride*).



7. Method for reducing the residual concentration of tannins

Testing of residual concentration reduction for 5 tannins (Quebracho, Chestnut, Mimosa, Myrobalan, and Gambier) using polymeric carriers biofunctionalized with the *Cerioporus squamosus* strain. The analysis results showed varying degrees of residual tannin reduction from the solution, depending on the tannin tested, with reduction values ranging between 5.56% and 41%.



DISSEMINATION, PATENT APPLICATIONS, FAIRS/EXIBITIONS, AWARDS:

- **WoS published papers: 6**

1. Ioana Corina Moga, Ovidiu Iordache, Gabriel Petrescu, Floarea Pricop, Iuliana Dumitrescu, Polyethylene based materials for biofilm carriers used in wastewater treatment, IOP Conference Series: Materials Science and Engineering, Vol. 374, No. 1, pg. 012080-012084; http://iopscience.iop.org/article/10.1088/1757-899X/374/1/012080/pdf;

2. Ovidiu Iordache, Ioana Corina Moga, Cornelia Mitran, Dana Ciutaru, Irina Săndulache. Novel MBBRs Systems Biofilm Carriers and Physical-Chemical Analysis. Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. VIII, 2019, Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064;

3. Ovidiu Iordache, Ioana Corina Moga, Cornelia Mitran, Dana Ciutaru, Irina Săndulache, Gabriel Petrescu, Elena

Perdum. Bio-Augmentation of Polyethilene Biofilm Carriers by Cerioporus squamosus White Rot Fungi. Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. VIII, 2019, Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064;

4. I.C. Moga, A. Bardi, S. Di Gregorio, F. Spennati, G. Munz, S. Batistini, O.G. Iordache, C.E. Mitran, G. Petrescu. Improved biofilm carriers for fungal exploitation in wastewater treatment. IOP Conference Series: Materials Science and Engineering, Volume 572, conference 1;

5. Microbial degradation of an industrial azo-dye and FT-IR analysis. Ovidiu Iordache, Ioana Corina Moga, Elena-Cornelia Mitran, Irina Săndulache, Lucia-Oana Secareănu,Cristina Lite, Maria Memecică, Adrian Tănasă, Georgiana Pantazi. Industria Textilă, Vol. 71, No. 6, 2020, DOI: 10.35530/IT.071.06.1835;

6. Cellulosic and Tannins Containing Wastewater Treatment Using MBBR Technology and Fungal Strain. IC Moga, OG Iordache, G Petrescu, EC Mitran, AG Tănasă, I Săndulache, GA Pantazi, LO Secăreanu, G Anghelache, C Lite. IOP Conference Series: Materials Science and Engineering 877 (2020) 012056.

- **BDI published papers: 7**

1. Ovidiu Iordache, Corina Moga, Iuliana Dumitrescu, Elena Perdum, Elena-Cornelia Mitran, Ana-Maria Andreea Chivu, Mariana Ferdeș, Floarea Pricop, MBBRs Functionalization with Cerioporus Squamosus. Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. VII, pg. 88-93, http://landreclamationjournal.usamv.ro/pdf/2018/vol2018.pdf;

2. Ioana Corina Moga, Ovidiu Iordache, Gabriel Petrescu, Cornelia-Elena Mitran, Elena Perdum, Floarea Pricop, Roxana Buzea, Education for the development of wastewater treatment technologies, AGIR Bulletin, nr. 3/2018, pg. 3-8, http://www.agir.ro/buletine/2975.pdf;

3. Ioana Corina Moga, Octavian Grigore Donțu, Floarea Pricop, Ovidiu Iordache, Gabriel Petrescu, Biological Wastewater Treatment Using Innovative Equipment and Materials, Proceeding of 9th International Scientific-Professional Conference Textile Science and Economy 2018, November 2018, ISBN 978-86-7672-314-0, pg. 27-32 http://tfzr.rs/tnp2018/files/Zbornik%202018.pdf;

4. Corina Moga, Ovidiu Iordache, Mitran Cornelia, Gabriel Petrescu. Polymeric Mobile Artificial Supports for Wastewater Treatment With Fungi Strains. "Book of Abstracts" - 10th International Conference on Environmental Engineering and Management - ICEEM 10, 2019;

5. Iordache Ovidiu, Moga Ioana Corina, Mitran Elena-Cornelia, Ciutaru Dana-Georgeta, Săndulache Irina-Mariana, Secăreanu Lucia-Oana. Chromatographic Characterization of Bemacid Rot Dye Compounds Following Cerioporus squamosus Bioremediation. Annals of the University of Oradea, Fascile of Textiles, Leather Work, Proceedings Volume XX 2019, ISSN 1843-813X;

6. Ioana Corina MOGA, Ovidiu IORDACHE, Gabriel PETRESCU, Elena Cornelia MITRAN, Irina Mariana SĂNDULACHE, Bogdan Iulian DOROFTEI, Lucia Oana SECĂREANU, Elena PERDUM, Georgiana Alexandra PANTAZI. Improved Mobile Bed Biofilm Reactors to Treat Cellulosic Wastewaters. Proceedings of International Conference "TexTeh IX", Advanced Textiles for a Better World, October 24-25, 2019, Bucharest, Romania. ISSN 2068-9101, Vol. 9;

7. Ovidiu IORDACHE, Irina SĂNDULACHE, Ioana Corina MOGA, Cornelia MITRAN, Lucia SECĂREANU, Elena PERDUM, Gabriel PETRESCU. DSC Analysis of Novel Polyethilene Biofilm Carrier. Proceedings of International Conference "TexTeh IX", Advanced Textiles for a Better World, October 24-25, 2019, Bucharest, Romania. ISSN 2068-9101, Vol. 9.

- **Scientific communications: 4**

1. Education – An essential component of environmental policy, June 7 Iunie 2018, Bucharest, Romania. Presented paper: "Education for the Development of Wastewater Treatment Technologies". Authors: Ioana Corina Moga, Ovidiu Iordache, Gabriel Petrescu, Cornelia-Elena Mitran, Elena Perdum, Floarea Pricop, Roxana Buzea;

2. International Conference "Agriculture for Life, Life for Agriculture", 07-09 Iunie 2018, Bucharest, Romania. Poster: "MBBRs Functionalization with Cerioporus Squamosus". Authors: Ovidiu Iordache, Corina Moga, Iuliana Dumitrescu, Elena Perdum, Elena-Cornelia Mitran, Ana-Maria Andreea Chivu, Mariana Ferdes, Floarea Pricop. http://fmvb.ro/english/evenim/209-agriculture-for-life-life-for-agriculture-2018;

3. International Conference on Innovative Research - ICIR, 17-18 Mai 2018, Bucharest, Romania. Poster: "Polyethylene based materials for biofilm carriers used in wastewater treatment". Authors: Ioana Corina Moga, Ovidiu Iordache, Gabriel Petrescu, Floarea Pricop, Iuliana Dumitrescu. http://fmvb.ro/english/evenim/209-agriculture-for-life-life-for-agriculture-2018;

4. International Conference "Textile Science & Economy IX", 06 Noiembrie 2018, Zrenjanin, Serbia. Paper:

"Biological Wastewater Treatment Using Innovative Equipment and Materials". Authors: Ioana Corina Moga, Octavian Grigore Donțu, Floarea Pricop, Ovidiu Iordache, Gabriel Petrescu. http://www.tfzr.uns.ac.rs/tnp/.

- **Patent Applications: 2**

1. A/00302 from 29.05.2020 – Biofilm carriers to be used in wastewater treatment – Ioana Corina Moga, Gabriel Petrescu (DFR Systems SRL);

2. A/00122 from 04.03.2020 – Materials for making different models of biofilm carriers – Ioana Corina Moga, Gabriel Petrescu (DFR Systems SRL).

- **Invention fairs/exibitions: 5**

1. EUROINVENT, European Exhibition of Creativity and Innovation, May 17–19, 2018, Iași, Romania. DFR Systems participated with its own booth, presenting 1 poster of the FunCell project;

2. International Fair of Patents, Inventions, Innovations and New Technologies – INOVAMAK 2018, September 21–23, Skopje, Macedonia. At the INOVA Invention Fair, DFR Systems presented 1 poster of the FunCell project, displayed at the booth of the Romanian Inventors Forum (FIR);

3. EuroInvent 2019 – European Exhibition of Creativity and Innovation. Participation with a poster for the Manunet project "Exploiting fungi potential for recalcitrant compounds removal from cellulosic wastewaters" FunCell;

4. ProInvent 2019, 17th Edition. Participation with the poster "Materials for the Development of Various Mobile Artificial Carrier Models," within the Manunet project "Exploiting fungi potential for recalcitrant compounds removal from cellulosic wastewaters" FunCell;

5. International Conference on Innovative Research – ICIR Euroinvent 2020, with the paper "Cellulosic wastewater treatment using MBBR technology and fungal strains.". Authors: Ioana Corina MOGA, Ovidiu George IORDACHE, Gabriel PETRESCU, Elena-Cornelia MITRAN, Adrian TĂNASĂ, Irina SĂNDULACHE, Georgiana Alexandra PANTAZI, Lucia-Oana SECĂREANU, Gabriel ANGHELACHE, Cristina LITE.

- **Awards: 6**

1. 2018 – Gold Medal awarded at INOVAMAK 2018 (International Fair of Patents, Inventions, Innovations and New Technologies);

2. 2018 – Certificate of Excellence awarded at EUROINVENT 2018 (European Exhibition of Creativity and Innovation);

3. Silver Medal for the Manunet project "Exploiting fungi potential for recalcitrant compounds removal from cellulosic wastewaters" FunCell, at EuroInvent 2019 – European Exhibition of Creativity and Innovation;

4. Special Award (Zagreb Inventors Association) for the Manunet project "Exploiting fungi potential for recalcitrant compounds removal from cellulosic wastewaters" FunCell, at EuroInvent 2019 – European Exhibition of Creativity and Innovation;

5. "The Green Environment AWARD" Certificate, awarded to DFR Systems, at EuroInvent 2019 – European Exhibition of Creativity and Innovation;

6. Certificate of Excellence and Gold Medal for "Materials for the Development of Various Mobile Artificial Carrier Models," at ProInvent 2019, 17th Edition.

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