UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Biological Processes for Biomass Valorization

2526-1-F7503Q032

Aims

The course aims to provide knowledge and skills in theoretical and practical terms regarding the potential of plant biomass and organic waste in the agricultural and industrial sector that can be used as raw materials for the production of bioproducts (including energy ones) / sustainable biomaterials through a circular economy approach.

1. Knowledge and understanding
   At the end of the course the student will have acquired knowledge and ability to understand (a) the origin and the characteristics of the different types of biomass in relation to their potential use in the valorisation processes (3) the biochemical processes for the extraction and the quantification of functional compounds or bioproducts (eg bioinsecticides) (4) bioenergy production technologies.
2. Ability to apply knowledge and understanding
   At the end of the course the student must be able to apply the knowledge acquired to the resolution of real environmental problems
3. Autonomy of judgment
   The students must be able to process what they have learned during classroom, laboratory and field lessons in order to choose the best approach to use for the valorisation of biomass from a circular economy perspective.
4. Communication skills
   At the end of the course the student will acquire not only the ability to express himself with an appropriate scientific language, but also the ability to relate to external operators in the sector.
5. Learning ability
   By the end of the course, students will have acquired the necessary skills to make informed decisions about the sustainable utilisation of biomass.

Contents

• origin and characterization of plant biomass used as feedstock

• the potential for biomass utilisation in relation to the technological processes employed.
• main strategies for the production of bioenergy and bioproducts for agriculture and environmental remediation; in particular, the following will be studied in depth:
• microbial metabolisms involved in the valorisation of organic waste (e.g. methanogenesis, fermentation and biosynthetic pathways)
• technologies for the production of biogas, hydrogen and electricity through microbial processes (eg, anaerobic digestion, microbial fuel cells) from organic waste
• bioelectrochemical technologies for power-to-gas
• production of substances with high added value through microbial biosynthesis (biosurfactants).

Detailed program

Topics of the lectures:
• Biomass and sustainability: analysis of socio-economic and environmental factors that indicate biomass as a material to be used for the production of bio-products (including bioenergy) from a circular economy perspective.
• Origin and types of biomass: waste biomass and biomass dedicated to specific purposes, their direct or indirect origin from plant organisms
• Characteristics of biomasses: chemical components of interest (lignin, cellulose, hemicelluloses, pectins, proteins, secondary metabolites) for the production of compounds with high added value (e.g. functional compounds, fungicides, soil improvers, specific products for bioremediation) and for bionergies
• Biochemical techniques for extraction, quantification and purification of compounds of interest
• Overview of technologies for bioenergy production: thermochemical, biological and physical conversion
• Definition of the essential parameters to be used to choose the suitable technology for the production of bioenergy according to the characteristics of the biomass available
• Microbial processes of methanogenesis and acetogenesis
• Processes and plants for the production of hydrogen, biogas and electricity through the exploitation of microbial metabolisms starting from organic waste
• Traditional and innovative processes and technologies for "power-to-gas"
• Processes and technologies for microbial biosynthesis of high added value substances starting from waste biomass

In the practical part, laboratory activities and data analysis will be carried out aimed at:
• establishing the characteristics of different types of biomass, in particular through the application of extraction methods and quantification of the different biomass components, the definition of the C/N ratio and the moisture content
• measuring the bi production potential of methane (Biochemical Methane Potential - BMP) in different laboratory systems with different biomasses, microbial inocula and temperatures and determine the characteristics of the microbial communities operating
• deepening, through the reading scientific articles, the most innovative aspects of the topics covered in the course
At the end of the theoretical and practical part, educational visits to bioenergy and composting plants will also be carried out.

Prerequisites

Basics of microbiology, botany and organic chemistry

Teaching form

16 h (8 2h-lessons). Delivered Didactics in presence
40 h lab activities (LiBaaS). Interactive Teaching in presence
20 h field activities (2 educational outings). Interactive Teaching in presence

Textbook and teaching resource

Scientific articles and slides provided through the e-learning platform

Semester

Second semester

Assessment method

Written exam consisting of open questions relating to the covered topics and practical experiences carried out during the course. The students are required to demonstrate the ability to deal with and critically discuss the principles and techniques object of the questions in relation to their application for the valorisation of biomasses and also in relation to the resolution of real environmental problems.
During the course there are two *in-itinere* written tests consisting of open questions. Passing both tests replaces the exam. The written exam could be integated with an interview.
Oral exam by choice.

Office hours

To be arranged by email

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | AFFORDABLE AND CLEAN ENERGY | SUSTAINABLE CITIES AND COMMUNITIES | CLIMATE ACTION