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AQUACULTURE AND AGRICULTURE BIOMASS SIDE STREAM PROTEINS AND BIOACTIVES FOR FEED, FITNESS AND HEALTH PROMOTING NUTRITIONAL SUPPLEMENTS	
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Bioproducts Innovations & Bioeconomy

A case study for +12 years old students

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the BBI grant agreement No 790956

Learning objectives

The aim of this case-study is to present knowledge about:

- ✓ The main types of bio-based products
- ✓ The processes used to produce bio-based products from biomass
- ✓ The types of biomass feedstock that can be converted to advanced biofuels

Key points

- ✓ Bioproducts are materials, chemical compounds and energy obtained from renewable biological sources;
- ✓ The main categories of bioproducts include: biomaterials (biofibres), bioplastics, biopharmaceuticals, biocosmetics, biochemicals, bio-based food & feed ingredients
- ✓ The processes used to produce bio-based products from biomass are mechanical/ physical, biochemical, chemical, and thermochemical;
- ✓ Waste biomass offers a potential way to overcome the concerns over using food materials for nonfood purposes.

Learning content

Introduction

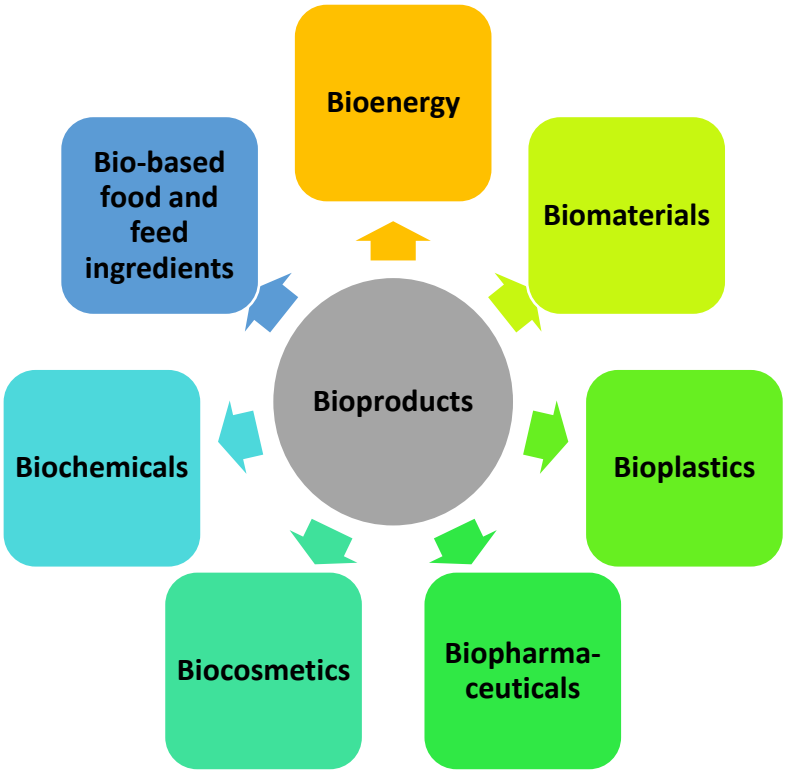
Bioeconomy came to light towards the start of the 21st century.

The general idea of bioeconomy is to develop energy, food and raw material supplies from renewable biological resources. Bioeconomy is a way to move away from fossil fuels and their derivatives. Bioeconomy can support sustainable development.

Biomass is a sustainable and bottomless resource, has many applications. Biomass side streams are of great interest for biobased economy because they do not to compete with food production. Biomass side streams are broadly accessible, sustainable and cost effective.

Different Types of Bioproducts

Bioproducts are materials, chemical compounds and energy obtained from renewable biological sources (e.g. agribusiness, forestry and organic waste etc.). There are several different types of bioproducts including:

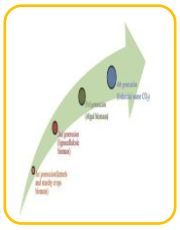


Bioenergy

Bioenergy is produced in liquid, solid or gaseous forms when organic matter is treated using different physical, biochemical, thermochemical and other types of processes.

Bioenergy

Bioethanol

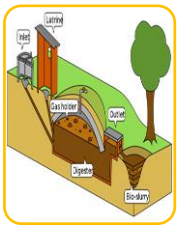


- Production: by fermentation
- Feedstock: biomass rich in carbohydrates (corn & wheat grains), lignocellulosic biomass or syngas [CO & H_2 mixture], algal biomass, industrial waste CO_2
- Often blended with petroleum-based gasoline or diesel
- Use: for transport or heating fuel

Biodiesel

- Production: by transesterification
- Feedstock rich in oils: soybean & canola, reused vegetable cooking oil, fats from animal rendering; or microalgae
- Green energy: nontoxic, biodegradable & renewable but expensive
- Use: pure (B100) or mixed with petroleum diesel: B2 (2% biodiesel), B5 & B20

Biogas (methane, carbon dioxide & other impurities)



- Production: by anaerobic digestion
- Feedstock: manure, harvest residues, dedicated energy crops & food processing residues
- Use: for power and heat
- Upgrading (elimination /transformation of CO_2) and cleaning (purification from impurities) improve the caloric value

Biomass (complex renewable material with fluctuating chemical composition)

- Feedstock: agricultural, animal, forestry & industrial residues, sewage & municipal solid waste
- Energy generation using simple or highly sophisticated technologies
- Use: for energy & secondary products (solid, liquid & gaseous fuels)
- Use for heat & power: burned directly or compressed (briquettes & pellets)

Together with other renewable resources (solar, wind and hydroelectric energy), biomass is a major future sustainable resource. The most recent bioenergy technology comprises pyrolysis, gasification, solar-to-fuel and genetic manipulation of organisms to produce hydrocarbons.

Other bioproducts

Biomaterials (biofibres)

- improved materials derived from renewable resources in a sustainable manner
- derived from wood, agricultural crop residues & purpose-grown crops (hemp & flax)
- use: in furniture manufacturing, paper & textiles, biocomposite materials in the car, aviation & other sectors

Bioplastics

- derived from organic biomass (in whole or in part) rather than petroleum
- produced from starch crops (corn, potatoes, wheat) & vegetable oils (canola or soybeans)
- use: in automotive, electronics, food & beverage packaging, agriculture, textiles, healthcare
- biodegradable; with smaller energy footprint; more environmentally friendly

Biopharmaceuticals

- medicinal products derived by extraction or semi-synthesised from natural sources (plants, microorganisms etc.), often by recombinant DNA techniques
- use: therapy (recombinant, protein, antibody, cell & gene therapy), prevention (vaccines) & diagnosis (monoclonal antibodies)

Biocosmetics (deodorants, shampoos, make-up, sunscreens, beauty and personal hygiene products)

- emerged through advanced technologies, such as nano- & biotechnology
- safe for humans & environmentally-friendly
- derived from industrial wastes (mainly vegetable oils, starches & proteins)

Biochemicals

- renewable building blocks and ingredients for the production of chemicals (detergents, biolubricants & chemicals for the oil industry; bioplastics, biologically based solvents, surfactants etc.)
- derived from renewable feedstock (typically plant-based, e.g. vegetable oil from corn, soybean & canola); with little harmful emissions
- sustainable advanced manufacturing processes; small environmental footprint
- price depends on the raw material & the cost & availability of technology

Bio-based food & feed ingredients (probiotics, prebiotics, dietary fibres, peptides, terpenes, phenols, nutraceuticals)

- derived from microbial, animal or plant sources; food wastes & by-products from food & feed industries
- produced from biomass through fermentation or enzymatic hydrolysis
- use: in food & feed industry (dairy products, beverages, oils & fats, animal feed, infant nutrition, snack foods & bakery goods etc.)

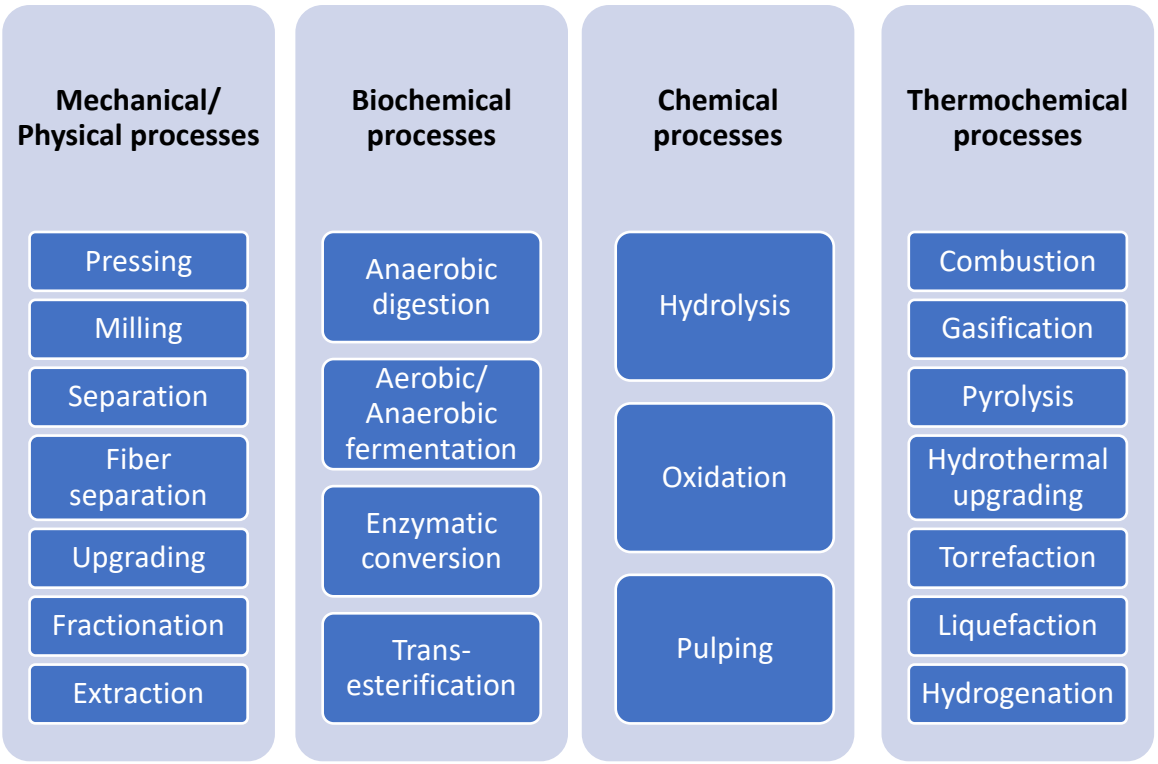
Benefits of growing new crops or plants for isolation of bioproducts and renewable chemicals:

- ✓ decreased reliance on imported oil and polymers
- ✓ lowered greenhouse gas emissions
- ✓ sequestration of carbon dioxide
- ✓ availability of complex structures produced by natural synthesis
- ✓ novel valuable products
- ✓ new industries
- ✓ better consumer acceptance of biobased products
- ✓ improved utilisation of land resources, especially in marginal farming areas and rangeland irrigation development areas.

Biochemicals must have a competitive price and a chemical and physical profile that is comparable with synthetic chemicals.

Bio-based products production processes

The processes used to produce bio-based products from biomass belong to four main groups:



Biowaste Valorisation

Bioeconomy proposes an opportunity to transform the bio-waste from a cost into a resource. Waste biomass offers a potential way to overcome the concerns over using food materials for nonfood purposes.

Types of valorized biowaste:

- **Used cooking oils** (UCO) or **recycled vegetable oils** (for aviation fuel)
- **Other oils originating from plants** (tall oil, residue from pulp industry, palm fatty acid distillate and by-products of the production of Omega-3-fatty acids from fish oil)
- **Potato peels** (for bioethanol)
- **Waste animal fat** (for biodiesel)
- **Municipal Solid Waste** (MSW) (for liquid biofuels; heat & power generation):
- ***Recyclable materials*** (metals, paper and plastics): for recycled products
- ***Organic fraction*** (putrescible food waste, garden waste): converted to biogas via anaerobic digestion
- ***Solid Recovered Fuel*** (SRF) (the fraction of MSW that cannot be recycled, e.g. shredded textiles, wood, paper, card & plastics): combusted or converted to syngas, & then used for bioenergy or processed into advanced biofuels

Food waste is part of the organic fraction. It is not suitable for direct energy generation through combustion because it has high moisture content and is very heterogeneous (i.e. blended with other types of household waste). This makes the processing expensive and technically complex. Increasing legislation and policy efforts in the EU aimed at prevention and reduction of food waste may limit possible investments in relevant process infrastructure and technologies.

Examples of biomass feedstock that can be converted to advanced biofuels by thermochemical, biochemical or chemical processes include waste from beer and other beverage production and waste from bakeries etc. The facilities that use this kind of feedstock follow a biorefinery approach improving the conversion of biomass and waste streams into products and energy.

Gained competences

Upon successful completion of this case study, the students will be able to:

- ✓ Know the main types of bioproducts
- ✓ Describe the basic features of each type of bioproducts
- ✓ Categorize the processes used to produce bio-based products into the main process groups
- ✓ Interrelate the types of valorized biowaste and the relevant to them advanced biofuels.