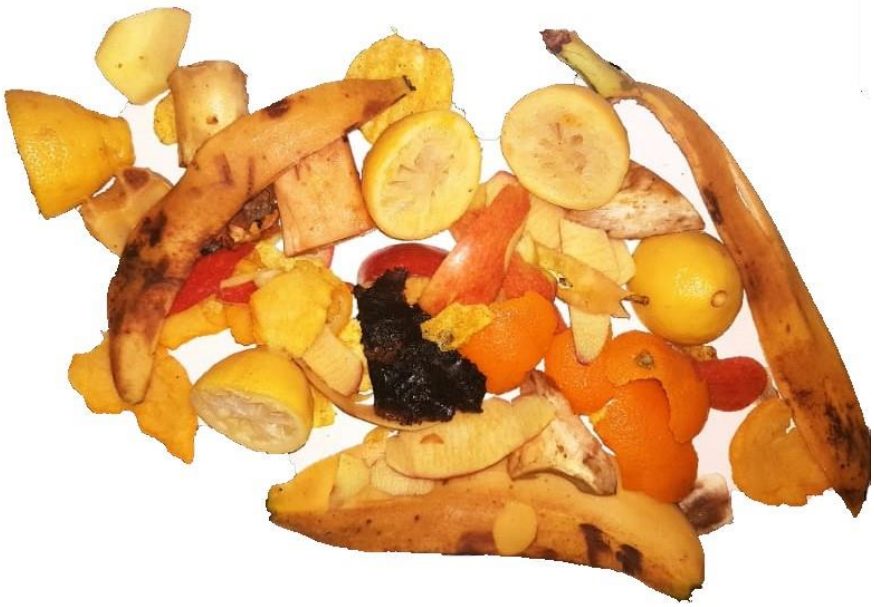
Whitepaper

Sustainable up-cycling of agriculture resources: modular cascading waste conversion system

"The world has enough for a man's need,
but not enough for a man's greed"
- Mahatma Gandhi



UpWaste

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

This project is funded in the frame of the ERA-NET FACCE SURPLUS; FACCE SURPLUS has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

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Sustainable up-cycling of agriculture resources: modular cascading waste conversion system

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Brief Introduction and Summary

The UpWaste project for the transformation of agricultural excesses into heterotrophic microalgal *(Galdieria sulphuraria)* and insect *(Hermetia illucens)* biomass quintessence on the improvement of a malleable and modular system. To construct an industrial blueprint of the UpWaste modular biorefinery system application it will be dependent on metabolic modelling with experimental calibration at lab and pilot industrial scales. Such a system will conclude the achievability of first-hand merchandises and amenities spawned through incorporated food and non-food systems and furthermore generate new market prospects. The UpWaste system, transfigures remainders based on a selection of species, which are miscellaneous and challenging to distinguish (e.g. manure, food waste, straw, and hull), with demarcated configuration into high-quality biomass. Following cascading, for the enlargement of innumerable merchandises fluctuating from food to chemicals by significant industries (creation of innovation potential for the associated industrial stakeholders) principles manufactured biomass will function as a substrate. For promising the security of mass-produced biomass as well as ascertaining the potential for the application as food and feed, Single-mindedness is mostly on recognition and circumvention of biological contaminations. To evaluate social acceptance, economic feasibility and environmental feasibility of the envisaged system Socio-economic and environmental impact analyses of supply chains will be executed. The interrelated experiments of agriculture is undertaken by UpWaste as well as the sustainable intensification of the agricultural sector, proficient practice of possessions and minor GHG emissions. In prevailing agri-food chains (agricultural and food waste and side-streams treatment) Holistic sustainability assessment of UpWaste integration will signpost trade-offs not only amongst dissimilar sectors (e.g. agri-food and energy) but also amongst several characteristics of sustainability (e.g. production and environment). Furthermore, probable hazards of rebound effects concomitant with the application of UpWaste modular system is demarcated by UpWaste, when the application of wastes for new product generation or side-streams may result in sophisticated fabrication tariffs of such wastes.

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The UpWaste project lasts for 36 months and is a collaboration of 6 different European partners. The project is led by the German Institute of Food Technologies (DIL) and following partners are involved: Institute for Food and Environmental Research (ILU, Germany), University of Warmia and Mazury (Poland), Latvia University of Life Sciences and Technologies (Latvia), Thomas more Kempen (Belgium) and KU Leuven (Belgium). UpWaste is funded within the FACCE SURPLUS (sustainable and resilient and agriculture for food and non-food systems) collaboration, which is committed to improve collaboration across the European research area in the range of diverse, but integrated food and non-food Biomass production and transformation systems including bio refining. FACCE SURPLUS is an ERA-NET cofund (part of the EU Horizon 2020 programme) between the European Commission and a partnership of 15 countries in the frame of the joint Programming Initiative on agriculture, Food Security and climate change (FACCE-JPI). For Thomas More, VLAIO-LA is the national funding agency within the ERA-NET cofund.

Relevance

Cascading use of agricultural residues can increase the efficiency of biomass use by 40-90% and reduce the environmental impact by 5-70%. Current bio-based technologies fail to target dynamic up-cycles for high-value components production and multiple use of wasted biomass. In application to agri-food chains bio economy approaches are represented in most cases via nutrient recycling options, when residue biomass is distributed on the lands in form of organic fertilizer. UpWaste builds on the knowledge gained regarding microalgal and insect biomass use to produce food, feed, chemicals, materials and energy and excludes the formation of specific compounds from formed biomass. UpWaste addresses diversified production systems (food, feed and chemicals production from agricultural residues) by making better use of natural resources (agricultural residues), encourage nutrient and carbon recycling (assimilation in microalgal and insect biomass), which corresponds to the focus of 3rd FACCE

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SURPLUS Call on “on the utilization of all biomass from agricultural land” “to food and non-food systems.”

Project Goals and Activities

The goals and activities of the UpWaste project can be divided into the following categories.

Each Goal is subdivided into activities associated with it:

- *Modeling and optimization of productivity*:
  1. Metabolic models development
  2. Organic residues model-based analysis at lab scale
  3. Organic residues utilization model-based analysis at pilot scale
- *Characterization of substrate and G. sulphuraria cultivation*:
  1. Characterization of substrate and hydrolysate
  2. Cultivation of alga at lab scale
  3. Cultivation of alga at pilot scale
- *Pre-treatment of residues and insect cultivation*:
  1. Characterization of organic residues
  2. Optimization of feeding substrate for rearing of high-quality larvae.

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First Results

Metabolic modelling approach is well known in silico method to mathematically analyze organism potential to utilize and distribute substrates through biochemical pathways. Metabolic models are based on organism (*G. sulphuraria and H. illucens*) genome sequence data. Metabolic models will be analyzed and validated and optimized to predict what organic residue compositions and mixtures are the best for high value compounds production like lipids and others.

UpWaste results in an innovative and flexible system for converting agricultural residues variable in composition into defined microalgal and insect biomass. Furthermore, it supports the sustainable intensification of the agricultural sector, efficient use of resources and lower greenhouse gases emissions and leads to alternative protein sources. UpWaste further focuses on safety of produced biomass and environmental and economic aspects to foster the social acceptance. The innovative character is not limited to technical aspects but is represented by close involvement of stakeholders (farmers, food companies and waste processors) enabling a need-based process development and its implementation.

After a protocol has been set up for the microbiological screening performed on substrates obtained from industry and waste processors, the results were compared to choose target pathogens that will be used for heat treatment experiments and to examine possible seasonal changes in microbial load.

Several potential raw materials for a compound substrate for BSFL rearing have been selected and collected from industry (mainly fruit and vegetable waste streams, chicken manure and grain residues). A protocol for microbiological screening (total aerobic count, Enterobacteriaceae, lactic acid bacteria, aerobic bacterial endospores, yeasts & moulds, Salmonella and coagulase positive staphylococci) has been set up. The screening has been performed on a first series of samples of these potential raw materials and a view on their microbial load is obtained. A second sampling round of the substrates will be organised to examine possible variations in the microbial load, due to

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for instance seasonality and/or regular batch-to-batch variation. In a further stage of the research, a standard mixture of a number of the raw materials will be prepared, inoculated with a food pathogen such as for instance Bacillus cereus or Staphylococcus aureus, and then heat treated using a range of time-temperature combinations to find out what treatment(s) provide a proper microbial reduction and at the same time allow good growth of BSFL.

Agricultural residues with low nutritional value and wastes are upcycled into algae and insect biomass with confirmed reliable quality. UpWaste uniting the bio-technological and industrial processes is aiming to provide technological means to develop a new market of products and services through integration of food and non-food systems. Value chains will be developed which can be integrated in relevant industries across rural regions. The approach provides knowledge addressing circular based bioeconomy, global food security and renewable raw material supply. This project is funded in the frame of the ERA-NET FACCE SURPLUS; FACCE SURPLUS has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

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