



*Lab scale extraction:
finding extraction parameters
for maximum yield*

Bye-bye by-products

Increasing agri-food sustainability and profits by reusing production residues

Food producers are facing several challenges: Reducing CO₂ emissions and adopting sustainable production, while staying economically viable. Reusing waste as a resource can help to achieve these goals. But the possibilities for finding new ways to reuse by-products is currently limited. For this reason, a European research project is developing a programme to help food producers repurpose their residues, creating an additional source of income.

One of the significant contributors to the climate crisis is food loss and waste. Food that is thrown away by the consumer is called food waste whereas food loss happens

during production, post-harvest, and processing of food. They annually account for the emission of 3.3 billion tonnes of CO₂. This means that when food is lost or wasted, all the CO₂ generated during production adds to our footprint without purpose. But also the resources used to create this food – including water, land, energy, labour, and capital – goes to waste.

That is why the question of how to improve food systems was one of the topics of the latest United Nations Climate Change Conference, COP27, held in Egypt in November last year. Drivers, causes and potential solutions for the climate crisis are discussed yearly at this conference. Critics claim that businesses

and governments must work faster to change course. “One bright spot in these crucial but otherwise frustrating climate negotiations has been the strong demand of civil society to include food systems in the debate through the presence of several food pavilions, side events and a dedicated Agriculture Day putting food systems well and truly on the radar of the world leaders charged with saving our planet,” reports Kelly Dent, global director of external engagement in World Animal Protection, an animal rights group.

Food loss is lost profit

In general, large amounts of food are lost. In the agri-food

“
**We will develop
a tool to find
the best way to
revalorise agri-
food residual
streams.**”

”

sector, for example, there is a [16 to 36 percent loss of fruits after harvesting](#) every year. Residual streams, parts of products that are not processed into food for human consumption by the food industry, could be reused and hence turned into profit. But most companies seldom know this.

“A roadmap for the food system could help investors to identify new, sustainable investment opportunities,” explains FAIRR investor Steve Waygood, chief responsible investment officer at Aviva Investors. Currently numerous commercial programmes aim to model, evaluate, and optimise industrial processes, but none simulates the entire value chain. However a European research project, Model2Bio, seeks to do that. This project will develop a new programme based on mathematical models to predict residual streams from the agri-food sector. For these residual streams, the programme identifies the best valorising routes. In other words, the programme suggests options to reuse production residues. Therefore, the model will

cover different aspects such as the composition, volume, and transformation of those streams as well as logistics and business cases.

„We will develop a tool to find the best way to revalorise agri-food residual streams. This tool will rely on models based on the results obtained in experimental work performed also in the project,” explains Luis Sancho, a researcher at the CEIT Research Center in Spain who is involved in the project.

Many by-products such as whey, brewers spent grain, artichoke residues, potato peels and the seeds and peels of tomato and grape have a high potential for recycling. These are the focus of the experiments in Model2Bio which test and improve extraction and fermentation processes for the reuse of by-products. „We selected these by-products for two main reasons. They are produced in high quantity but also because there are already previous investigations that support our ideas to revalorise these residual streams,” describes Camille Malterre, researcher at Celabor, a Belgium scientific and technical services centre also involved in the project. To validate the data and make the model of the project more robust it is necessary to perform these experiments several times.

Turning production residues into extra revenue

But what is meant by extraction? „What we aim for is



*Pilot scale extraction:
prototype production to
confirm the extraction protocols
established at lab scale.*

to separate certain compounds that plants contain like sugar or cellulose, which are usually mixed," points out Malterre. Extraction processes must still be optimised to obtain the greatest possible amount of the compound. An example to comprehend how optimisation of extraction processes work is coffee. Coffee extraction is simply the process of dissolving coffee in hot water. But there is a science to getting the perfect-tasting cup of coffee. The roast of the coffee, the size of the grind, the temperature of the water, the ratio of water to coffee and the amount of time that the water is in contact with the coffee play a vital role for successful coffee extraction. Model2Bio also considers these parameters (temperature, pressure, solvent, duration time etc.) when performing

“ We can utilise sugar components from by-products and convert them into high-value products such as low calory sweeteners, oils, or improved compounds for animal feeds.

”

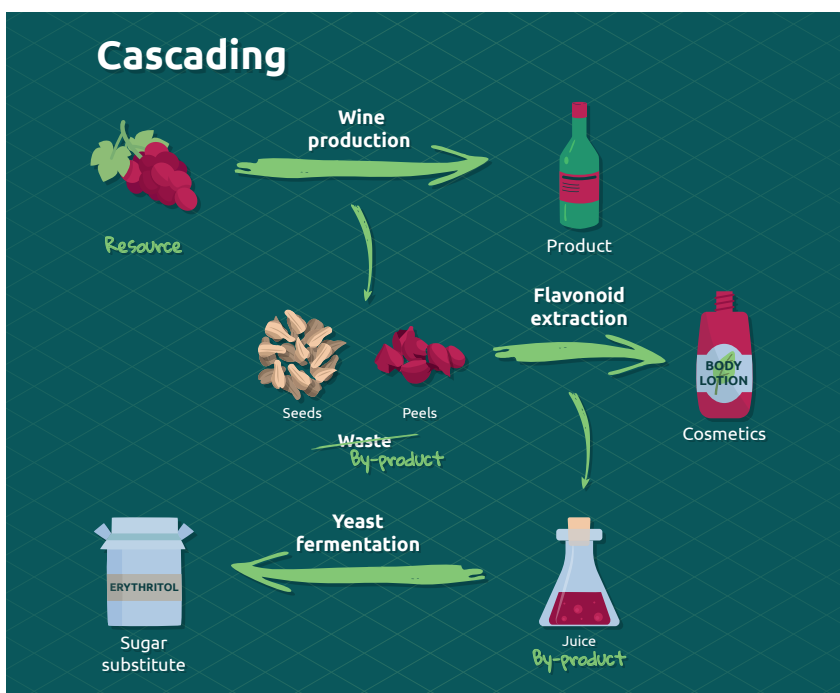
extraction on agri-food residual streams.

Fermentation is the breakdown and conversion of a substance by bacteria, yeasts, or other microorganisms. In this process, new valuable compounds are produced by the microorganism. „Through fermentation, we can utilise sugar components from by-products and convert them into high-value products such as low calory sweeteners, oils, or improved compounds for

animal feeds, “ explains Lolke Sijtsma, project leader and senior scientist at Wageningen Food and Biobased Research, a partner in the project.

Maximising the use of resources

Efficient use of resources becomes ever more important. And one way to do so is cascading, to use the most of the agri-food industry’s side products. This process tries to



The use of resources can be maximised by reusing grape seeds and other by-products in coupled processes. This is called cascading.

first extract the most valuable products and use the residues generated during the first treatment round for additional recycling processes, like fermentation.

Cascading can be performed on grape seeds and peels, among others. During the production of wine, seeds and peels are removed and do not continue in the wine production chain.

They are high in fibres which contain flavonoids, valuable resources for the cosmetics and food supplement sector. Flavonoids can be extracted from fibres after separating these from the pomace in a process called 'slow juicing.' After the separation of the fibres, the remaining juice is still rich in glucose and fructose making it an interesting resource for fermentation. „We can produce erythritol through a fermentation process with Moliniella, a yeast that needs oxygen and sugars to grow. Erythritol is a low-calorie sweetener that is indicated as an alternative product for

people suffering from diabetes or other related metabolic syndromes,” explains Sijtsma. Cascading with its chain structured process revalorises different components of one by-product. The Model2Bio tool will identify such cascading processes.

A programme to help industries reuse production residues

After the performance of the experiments, the tool will use their data together with additional information about environmental, ethical, and economical aspects. Based on all this information the

programme will give the most sustainable and economical solution so companies can make the most out of their by-products. „Most of the residual streams still contain valuable components, and in the future, resources will become increasingly scarce, so we must make the most of it,” explains Malterre from Celabor. „Currently, there are not many alternatives for bio-industries to reuse the by-products that they produce,” points out Sancho from Ceit. Bio-industries could benefit from the tool and make money out of these by-products, turning what is considered waste into a source.

“
Most of the residual streams still contain valuable components, and in the future, resources will become increasingly scarce, so we must make the most of it.

”



Horizon 2020
European Union Funding
for Research & Innovation

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 887191. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.