Abstract

Anna Twarogowska

Promotors: Prof. Dr. Luc Pieters (UA); Dr. Ir. Bart Van Droogenbroeck (ILVO)

In recent years, the agrifood sector faced many global challenges, where climate issues are emerging, food insecurity and economic instability are increasing due to the ongoing pandemic (COVID-19), and geopolitical instability, including military conflicts. Furthermore, globalization of the food market caused the enormous growth of the food supply chain, where industrialized food processing generates significant amounts of residues and by-products. Thus, reducing the agrifood processing residues and by-products by valorizing them into value-added products are an emerging topic. The concepts such as circular economy, bioeconomy, biorefinery, and zero-waste are encouraged to improve the usage of resources and increase sustainability throughout the food system.

Belgian endive (*Cichorium intybus* var. *foliosum*) is an economically important vegetable in Europe, especially in Belgium, France, The Netherlands, Italy, and Germany. In 2020 in the EU, approximately 0.63 Mt of leafy crops (chicons) were produced, generating forced roots as by-products. Forced roots are a very interesting feedstock for the biorefinery concept thanks to their year-round availability and attractive chemical composition, being rich in sugars, dietary fibres (DF), and bioactive compounds such as phenolic compounds (PC) and sesquiterpenes lactones (SLs).

This PhD aimed to develop an innovative biorefinery processing method to transform underutilized forced roots into value-added products, which could be further used in multiple applications ranging from food and beverages to cosmetics, pharmaceuticals, and biomaterials.

Using the cost-efficient biorefinery process with water as solvent created zero-waste production process where two valuable fractions (solid and liquid) were obtained. A solid fraction was transformed into dietary fibre concentrate (DFC), a functional ingredient with low sugars, high dietary fibre content, and excellent functional properties such as water and oil holding capacities and swelling capacity, which can be used in various products. Incorporating the Belgian endive DFC into plant-based burger formulations resulted in lower caloric value and sugar content, higher dietary fibre content and improved baking properties.

The SL-rich aqueous fraction that is a by-product of the DFC production (liquid) was stabilized by spray-drying and used to extract and isolate sesquiterpene lactones. The simple, easy to upscale fractionation process by using EtOAc:H_2O used in this work could be an alternative to expensive, labor-intensive, commonly used methods like flash chromatography and TLC. The spray-dried aqueous fraction showed potential to use as a promising starting material for isolation of SLs, which can be used to produce value-added applications, such as cosmetics and food, and novel drugs.