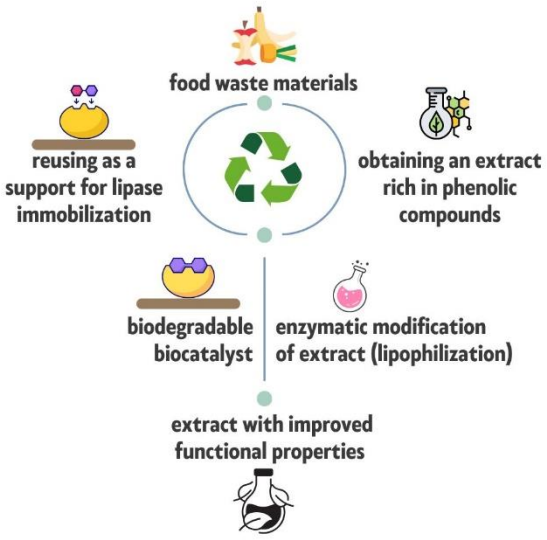
Food Waste as a Bioplatform: Carriers for Lipase Immobilization and a Source of Polyphenols in the Enzymatic Lipophilization of Bioactive Compounds

It is well known that phenolic compounds are a large and diverse group of secondary metabolites found mainly in plants, as well as in fungi. In recent years, interest in these compounds has increased due to their functional characteristics, such as antioxidant, anti-inflammatory, antimicrobial and anticancer properties, which translates into their biological, nutritional and pharmacological importance. Unfortunately, these compounds are not without drawbacks. One of them is their low solubility in fats and oils, so it is necessary to "lipophilize" them, i.e. improve these properties by adding hydrophobic molecules (fatty acids or fatty alcohols) to phenolic compounds, resulting in esters. Lipophilization makes it possible to increase the solubility of the obtained esters in organic environments, and thus in lipids. In addition, in many cases, enzymatic modification also improves the biological activity of polyphenols. To carry out the above-mentioned reactions, according to the Green Chemistry approach, enzymes, specifically lipases, belonging to the hydrolase class, can be used.

In order to obtain a stable enzyme preparation, an immobilization technique is used, which involves immobilizing enzyme protein molecules on a specially prepared carrier. This allows protection of the enzyme from environmental stress factors, as well as the possibility of easy separation and purification of products from reaction mixtures and efficient recovery of biocatalysts. A new trend is the search for more environmentally friendly matrices to create a fully biodegradable biocatalyst as a new alternative to synthetic carriers.



The project assumes the utilization of the food-production waste, especially from beverage production, **in a dual form**. The **main goal** is to **use food waste material both as a carrier in the immobilization process** to develop novel biocatalysts of microbial origin **and as a source of polyphenol-rich extracts.** The research will focus on the study of one group of polyphenols, specifically **phenolic acids**. The obtained immobilized lipase preparations will then be evaluated for their ability to modify single phenolic compounds and whole polyphenol extracts to improve their lipophilicity. Importantly, the synthesis reaction mechanisms will be modelled using *in silico* methodologies, in order to gain structural insights into the functioning of the studied enzymes and guide the selection of novel substrates. As a final step, we will evaluate key parameters of the newly obtained compounds and whole extracts, such as antioxidant potential, antimicrobial activity and solubility in lipid food matrices, to increase the applicability potential of the project. Selected safety features of use will also be evaluated (cytotoxicity).

The project includes five research tasks aimed at carrying out enzymatic modification of phenolic acids present in the extract, obtained from food waste, in order to obtain their derivatives with functional properties. The results obtained will form the basis for further research and applying for further funds from the sources of the National Science Center in competitions such as OPUS or SONATA.