Objective of the project

The main aim of the proposed research will be the development of an **innovative analytical procedure for direct monitoring of secondary products of oils' oxidation generated during deep frying.** In the research project an approach in which **indicators of the degree of degradation** of frying oil will be proposed. Additionally, **changes in the concentration of carcinogens** from the IARC list will be monitored in the frying fumes. The impact of various parameters of the frying process on the composition of the generated fumes will also be investigated.

Rationale behind choosing the research topic

One of the priorities in the production of food is ensuring the proper quality of food products. This applies not only to end products, but also to raw materials from which they are produced and intermediates created during the food preparation stage. Frying is one of the most popular methods of food processing. As a result of the frying process, due to high temperature, numerous different chemical reactions can take place in which the substrates are food ingredients, ambient air constituents and oil. **These reactions include oxidation**, hydrolysis, polymerization, cyclization and Maillard reaction. **The products of these reactions are chemical compounds consumption of which may have a detrimental effect on human health**. The products of thermal degradation of edible oils can cause neoplastic changes, cardiovascular diseases, and also Alzheimer's and Parkinson's diseases. A considerable proportion of the chemical compounds formed during frying belong to the VOCs group. Secondary products of oil oxidation are one of the main groups of volatile organic compounds generated during frying. These include short-chain saturated and unsaturated aldehydes and ketones. Their presence in the fumes raising from the utensil in which frying takes place can provide valuable information about the degree of oils' degradation, but also about the exposure to these chemicals of those near to the source of emission**. The development of an analytical procedure which could be used to monitor changes in the composition of fumes emitted during frying would allow a better understanding of the formation of compounds from the VOCs group during degradation of oils.** The currently used methods either do not enable real-time measurement or are used to determine the composition of the oils' headspace which differs from the composition of the fumes generated during frying.

The solution could be to use a device which allows the monitoring of the concentration of a wide range of compounds from the VOCs group in real time, without the need for sample preparation and characterized by high sensitivity. **The proton transfer reaction mass spectrometer coupled with time-of-flight analyzer (PTR-TOFMS) is precisely such a device.** In it, due to the reactions of hydronium ions (which are the proton donors) with volatile organic compounds characterized by a given affinity for the proton, ions are formed which are then detected and determined. However, proton transfer reaction mass spectrometry has some limitations, among which the most important is the lack of accurate identification of chemical compounds. To solve this problem, in this project comprehensive two-dimensional gas chromatography coupled with TOFMS detector (GC×GC-TOFMS) with which it is possible to qualitatively determine the exact composition of the fumes is used. By combining the use of these techniques, a complementary, comprehensive solution is obtained which can be used for both qualitative and quantitative analysis of the composition of fumes generated during the frying process. The big challenge will be to sample the fumes generated during frying and introduce the samples into both of these devices. Therefore, it is planned to create a proprietary, dedicated solution in which the fumes are continuously sampled for analysis using PTR-TOFMS, while the technique of solid-phase microextraction (SPME) will be used for qualitative analysis. **A complete solution involving both a sampling system and the developed analytical procedure will represent an important scientific novelty and a contribution to basic research.**

In summary, in the proposed project it is planned to develop a **comprehensive analytical procedure complete with a sampling system and involving the use of complementary techniques of GC×GC-TOFMS and PTR-TOFMS in order to assess the degree of degradation of frying oil and to monitor changes in the concentration of harmful substances emitted during frying.**