Beetroots constitute a valuable raw material due to the high content of nutrients. Their consumption limits the possibility of many civilization diseases. Therefore, there is a need to include them into a daily diet. Beetroots are most often eaten fresh or cooked. In the autumn-winter period, when access to fresh seasonal vegetables and fruits is limited and the number of infections increases (especially during the COVID-19 pandemic), it is worth to provide valuable vitamins and bioelements to the body by including into the daily diet e.g. fermented beetroot juice or dried beetroot chips. Fermentation of beetroots, results not only in health-promoting fermented beetroot juice, but also partially dehydrated beetroots. Although fermented beetroot juice is a ready to drink finished product, fermented beetroots often constitute waste. The reason is the fact that fermented beetroots are characterized by undesirable organoleptic properties (texture), i.e. high hardness. Nevertheless, this product still has a high nutritional value and can help e.g. with anemia, weight loss, kidney and liver functions. The use of ultrasound and pulsed reduced pressure may accelerate dehydration process and have a good effect on the physicochemical properties of both fermented beetroot juice and fermented beetroot tissue and then may help in waste management and use them, as e.g. soup's or salad's ingredients. Another option is to dry the fermented beetroots and get a snack in the form of fermented beetroot chips. Drying with hot air is time-consuming and often results in low quality of dried product. An interesting solution is e.g. microwave-vacuum drying. However, the high cost makes it usable mainly for finish drying of low moisture content materials.

Therefore, the authors of the project plan to work on ultrasound assisted osmotic dehydration of beetroots conducted under reduced pressure. Additionally, the authors plan to work on the drying of fermented beetroots using two-stage drying process involving initial convective drying combined with finish microwave-vacuum drying. In addition, the authors plan to undertake works on the intensification of convective drying by ultrasound, microwaves and infrared radiation. The reason for undertaking the work is the lack of scientific literature on the topic being implemented.

The aim of the study is to evaluate the effect of ultrasound and reduced pressure on the kinetic of osmotic dehydration and physicochemical properties of the fermented beetroot juice and fermented beetroot tissue. In addition, the aim of study is to evaluate the effect of combined two-stage drying process of fermented beetroots on the convective-microwave-vacuum drying kinetics and properties of dried fermented beetroot chips. Convective drying will be assisted by ultrasound, microwaves and infrared radiation.

The specific objectives of the project are:

(i) determination of the effect of ultrasound assisted pulsed vacuum osmotic dehydration (US+PVOD) as well as material properties (particle size and shape) on the kinetics of changes in osmotic solution (fermented beetroot juice);
(ii) determination of the effect of ultrasound assisted pulsed vacuum osmotic dehydration (US+PVOD) as well as material properties (particle size and shape) on the kinetics of changes in beetroot tissue;
(iii) determination of the effect of different conditions of the combined ultrasound/microwave/infrared radiation assisted convective drying (C+US+MW+IR) with microwave-vacuum drying (MWVD) on the drying kinetics of osmotically dehydrated (fermented) beetroot tissue;
(iv) determination of the effect of ultrasound assisted pulsed vacuum osmotic dehydration (US+PVOD) on the kinetic of combined ultrasound/microwave/infrared radiation assisted convective drying (C+US+MW+IR) with microwave-vacuum drying (MWVD);
(v) determination of the effect of ultrasound assisted pulsed vacuum osmotic dehydration (US+PVOD) and combined ultrasound/microwave/infrared radiation assisted convective drying (C+US+MW+IR) with microwave-vacuum drying (MWVD) on the properties of dried fermented beetroot chips.

The results will help to explain the effect of ultrasound and/or microwaves, infrared radiation, reduced pressure on the kinetics of the osmotic dehydration and combined convective with microwave-vacuum drying, as well as the physicochemical properties of the material. The research results will be able to serve as a starting point for future research on the modification of the properties of dehydrated materials and broaden the knowledge about the use of ultrasound, pulsed reduced pressure, microwaves and infrared radiation to support dehydration and drying processes.

To evaluate the changes in color, texture or nutritional value of fermented beetroot juice, osmotically dehydrated (fermented) beetroots and beetroot chips, modern techniques, such as spectrophotometry, chromatography, differential scanning calorimetry, gas pycnometry, computer image analysis, scanning electron microscopy, or texture analysis will be used.

The results will develop the knowledge in various fields of science, including food technology and nutrition, mechanical engineering, chemical engineering and others.