**Objectives**

In this project we intend to develop a new type of reactor, which will enable a new Hybrid Technology – MUST to be developed and which will allow simultaneous treatment with ultrasounds and microwaves. This new equipment will be based on an existing microwave equipment from our laboratory, the LABOTRON XS2000; this system is equipped with a 1.5 L metal (stainless steel) reactor within which microwave energy is introduced directly into the reaction medium using a patented system - Internal Transmission Line (INTLI) - developed by the French company SAIREM. In this reactor we intend to apply a multi-frequency ultrasound generator with the frequency adjustable between 20 kHz and 1100 kHz and the power >20 W. This will enable the conception of a new hybrid reactor, thermostated, in which a reaction mixture up to 1.5 L can be fed and within which the microwave and/or ultrasound energy can be supplied simultaneously.

The use of the Comsol® Multiphysics modeling software to implement a 3D model to investigate the simultaneous use of microwave and ultrasound fields in the new reactor is another objective proposed in the first construction stage of the MUST reactor. The literature is very poor in models that can predict the behavior of various media undergoing simultaneous microwave and ultrasonic treatment.

Another objective is the study of the indirect influence of ultrasounds on the heat dissipation of microwave energy, by changing the dielectric properties of liquid solvents, by inducing anisotropy due to the appearance of acoustic nodes and antinodes. Although this topic is very important and can explain the intensification of physico-chemical processes through the synergistic effect of microwaves and ultrasound, it is a topic rarely discussed in the literature.

The efficiency of the new reactor will be evaluated through three different processes:

* Extraction of liposoluble principles from plants (carotene, lycopene, etc.) in the presence of a biodegradable and biocompatible solvent (e.g., ethyl esters of fatty acids - FAEE). FAEE have been used in the food and food supplements industries and are also used as a substitute for omega-3 fatty acids in fish oil. FAEE are on the list of food additives allowed for direct addition to food for human consumption [ 21CFR 172.515]; their value increases if made out of vegetal oils rich in omega -3 and omega -6 fatty acids (hemp, camelina, etc.).
* Obtaining polyol type compounds from biomass resources. Polyols, precursors of polyurethane and polyisocyanurate foams, are a recent topic of interest because of the significant growth of the worldwide foam market over the past few decades. Bio-polyols can be obtained by the solvent liquefaction of lignocelulosic materials blended with polyethylene glycol or glycerol under a range of operating conditions or by the oxypropylation reaction using an alcoholic solution with 1% KOH (w/v). The influence of intensification with MW and US has not been studied for polyols’ preparation.
* Synthesis of calcium alginate in the reaction between sodium alginate and calcium chloride in the presence of microwaves and ultrasounds, as an environmentally friendly heavy metal ion exchanger. To help with this topic, we will use previously obtained results on the synthesis of calcium alginate in the presence of ultrasounds.