Annotation

Artemiev Artem Ilyich, the Lead Engineer of the Department of Chemical and Pharmaceutical Engineering, Mendeleev University of Chemical Technology, has completed a dissertation on the topic: "Supercritical extraction of biologically active substances from aralia, ginseng, and multiphytoadaptogen."

Relevance of the research topic. At present, much attention is paid to the development of low-tonnage chemistry, the production of reagents, highly pure substances, and unique chemical compounds. It is small-tonnage chemistry that opens new opportunities for the creation of innovative pharmaceuticals, and, in particular, the extraction of biologically active compounds from plant materials. This is emphasized in the government's order "Strategy for the Development of the Pharmaceutical Industry of the Russian Federation for the period up to 2030". In addition, the government pays great attention to the creation of high-tech domestic equipment. The use of new supercritical technologies on an industrial scale to obtain biologically active compounds from plant materials is an extremely urgent task, which will, firstly, allow to obtain new compounds for pharmaceuticals, and secondly, create new equipment for the supercritical extraction process. Supercritical extraction is a "green" resource- and energy-efficient technology which makes it possible to abandon expensive organic solvents, reduce the processing time due to accelerated mass transfer, and conduct processes at low temperatures.

The present research is devoted to theoretical and experimental studies of the plant materials extraction processes, and intensification of the supercritical extraction procedure by various instrumental and constructive methods.

The purpose of the research is to theoretically and experimentally study the extraction process of biologically active substances via supercritical extraction.

Objectives. To achieve the goal, the following scientific and technical objectives were set:

1. Investigation of the supercritical extraction process of biologically active substances from plant materials.
2. Comparison of supercritical and liquid extraction processes.
3. Intensification of the supercritical extraction process of biologically active substances from plant materials using ultrasonic treatment.
4. Simulation of the technological scheme of the supercritical extraction process of biologically active substances from plant materials using the ChemCad software package.
5. Scale-up of the supercritical extraction process.

Scientific novelty. The influence of the three-component system "ethanol - water - carbon dioxide" composition on the process of supercritical extraction has been studied. The process of supercritical extraction of aralosides from aralia, ginsenosides from ginseng, and biologically active substances from multiphytoadaptogen have been studied, which showed a high yield of biologically active substances compared to liquid extraction.

The effect of ultrasonic vibrations has been studied, which made it possible to intensify the mass transfer of the supercritical extraction process.

A process flowsheet of a laboratory machine for carrying out the supercritical extraction process has been developed in the ChemCad software package. Using the developed process flowsheet, calculations of the material and heat flows that are necessary for the extraction of ginsenosides from ginseng using the supercritical extraction process have been carried out.

The process of supercritical extraction of ginsenosides from ginseng was scaled up using the ChemCad software package. Based on the model, a process flowsheet of a pilot plant was proposed for carrying out the process of supercritical extraction with recovery and recycling of carbon dioxide.

Theoretical and practical significance of the research. A complex of experimental studies on the extraction of biologically active substances from plant materials using supercritical extraction has been carried out. The obtained results allow us to assert the possibility of using supercritical technologies to extract aralosides from aralia.

An analytical method has been developed for determining the composition of extracts using high-performance liquid chromatography with tandem mass spectrometry. The processes of supercritical and liquid extraction were compared. Using high-performance liquid chromatography with tandem mass spectrometry, it was found that the ginsenosides in the ginseng extract and the aralosides in the aralia extract obtained during the supercritical extraction process are contained in a larger amount than in the extracts obtained by the liquid extraction process.

Calculations of material and heat flows in the process of supercritical extraction of biologically active substances from ginseng in a laboratory setup were carried out in the ChemCad software package. The results were used to calculate the capacity of the required equipment.

Defense provisions. Results of experimental studies of the extraction process of biologically active substances from plant materials: aralia, ginseng, and multiphytoadaptogen. The results of theoretical and experimental studies of the three-component system "ethanol - water - carbon dioxide" influence on the process of supercritical extraction at a temperature of 323.2 K and a pressure of 12 MPa.

Results of experimental studies of pressure, temperature, and ultrasonic exposure influence on the kinetics of the supercritical extraction of biologically active substances process from aralia.

Results of experimental studies of the intensification of the process of supercritical extraction of ginsenosides from ginseng using ultrasonic treatment.

The model of the technological scheme of the supercritical extraction process on the laboratory installation of ginseng ginsenosides was developed in the ChemCad software package, and based on the model of the process flowsheet of the laboratory installation of supercritical extraction, a large-scale transition to a pilot installation of supercritical extraction. Process flowsheet of supercritical extraction of ginsenosides from ginseng with the possibility of recycling and recovery of carbon dioxide.