Universidad de Burgos	**MSc Program: Advancements in Food Sciences and Biotechnologies** **MSc in Food Safety and Biotechnology** Department of Biotechnology and Food Science Faculty of Sciences University of Burgos

COURSE						**CODE**
Supercritical Fluids in the Food Industry						7450
Tuition Period (semester)	Duration (in months)	Type (Mand/Op)	ECTS Credits	Hours (theoretical)	Hours (practical)	Hours (other activities)
Semester 1	1	Op	4	18	18	64

LECTURER IN CHARGE OF COURSE (1)			
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3.3.1. SPECIFIC EDUCATIONAL OBJECTIVES

OBJECTIVES:

1. Acquire the ability to decide on the feasibility of supercritical fluid technologies for a specific application and discern those in which these processes would not be viable or competitive.
2. Acquire a critical vision of industrial processes and emphasize on the study and implementation of processes that use clean technologies.
3. Understand the operation of a supercritical fluid extraction plant and interpret the results of the monitoring of the process

COURSE PROGRAMME SUMMARY:

THEORETICAL:

Unit 1. Introduction

Topic 1. Introduction. Course objectives, competences and methodology. Pressurized fluids: dense gases and / or supercritical fluids. Pressurized fluids as separation agents. Pressurized fluids as reaction media.

Unit 2. Fundamentals

Topic 2. Properties of compressed fluids and mixtures with sub or supercritical components.

Definition of supercritical fluid. PVT diagram. Thermodynamic properties. Transport properties. Other properties of interest. Thermodynamics of the equilibrium between phases at high pressures. Transport of heat and material at high pressures

Unit 3. Processes

Topic 3. Supercritical fluid extraction processes (EFSC). Extraction with supercritical fluids of substances contained in solid substrates. Influence of the process parameters and raw material pre-treatment of the in the extraction performance. Circulation of the solvent. Solvent separation of dissolved substances. Multistage countercurrent extraction. Extraction processes modeling. Industrial applications: coffee Decaffeination, extraction of fats and oils, hops extraction and fractionation, etc.

Topic 4. Preparation of materials using supercritical fluids. Fundamentals of particle precipitation. Processes in which a FSC acts as a solvent, cosolvent, anti-solvent or solute. Formation of microspheres spheres and micro-capsules. Industrial applications: lecithin production.

Topic 5. Inactivation of microorganisms and enzymes at high pressures. Inactivation of microorganisms by high pressure carbon dioxide (HPCD). Enzyme inactivation by HPCD. Inactivation mechanisms. Sterilization through high hydrostatic pressure (HPP). Industrial applications.

Topic 6. Reactions in supercritical media. Enzymatic reactions in supercritical fluids. Hydrogenation of oils in supercritical fluids. Oxidation in supercritical water. Other reactions of interest in supercritical media.

Topic 7. Chromatography with supercritical fluids (CFSC). Fundamentals of the CFSC. Industrial applications. Production of omega-3 polyunsaturated fatty acid concentrates.

Topic 8. Other processes that use supercritical fluids. Impregnation. Protection and waterproofing of woods. Cleaning. Cleaning of cork. Dry cleaning. Surface coating. Others

Unit 4. Equipment and Security

Topic 9. Design and construction of high pressure equipment. Regulations for the construction of pressure equipment. Pressure vessels. Equipment for solvent pressurization. Pipes, valves and accessories. Pilot plants and industrial equipment.

Topic 12. Safety in process plants operating at high pressure. Risks Identification. Reduced risk in design, operation and maintenance. Legislation, standards and design codes.

PRACTICAL OR EXPERIMENTAL:

Unit 5. Laboratory Practices

Laboratory practice 1. Visualization of the critical point of a substance and the ion of the changes that occur in a substance when its pressure and temperature conditions move along its saturation curve and reach the critical point.

Laboratory practice 2. Equations of state and critical point. Measurement of the P vs V isotherms, the vapour pressure curve and the critical point of ethane or Surfur hexafluoride.

Laboratory practice 3. Elements, structure and operation of equipment and plants operating at high pressure. Elements and structure of an EFSC plant with solvent recirculation and operation for the processing of a food product. Elements and structure of a dynamic analytical equipment for determination of solubility of solids in compressed fluids and operation for the determination of the solubility of caffeine in compressed CO_2 at different pressures and temperatures.

3.3.2. TEACHING METHOD:

Learning Activities

Lectures and discussion in the classroom will be used to present the different units to the students. Each unit has a questionnaire containing most of the questions that the student should know how to answer.

Practical sessions will take place in the laboratories where the pressurized fluid equipment is placed and students will write a report on the results of the laboratory work.

The students should perform a critical report on scientific publications dealing with a supercritical fluid process of their own interest and present it to the rest of the students.

In-person tutorials will be held throughout the semester at the request of students at the established time.

ECTS credit allocations (Approximate Student workload in hours):

		Hours
Classroom setting	Lectures / Directed discussions	13
	Practical Classes (and laboratory notebook compilation)	7
	Seminars	8
	Tutorials	2
	Essays - Presentations	4
	Assessment Tests	2
	On Site - Total Hours:	36
Off campus	Workload to prepare theoretical and/or practical classes	20
	Resolution of exercise, practical cases and questionnaires	24
	Workload to prepare exams and/or evaluation tests	10
	Critical Works on Scientific Publications	10
	Off-Campus - Total Hours:	64
	WORKLOAD - TOTAL HOURS:	100

3.3.3. ASSESSMENT CRITERIA AND METHOD

The evaluation will be continuous through the assessment of the development of the different activities that are proposed throughout the course.

The final grade will be obtained by performing the weighted average of the rating of each of the procedures; However, to achieve this average it will be necessary to achieve a minimum score of 40 % in each of them.

NON-RECOVERABLE EVALUATION PROCEDURES: The classroom activities carried out during the seminars will not be recoverable.

Students caught copying or plagiarizing in any of the evaluation procedures of the subject, will have a zero grade in the global grade of the subject, according to article 17.2 of the Evaluation Regulation of the University of Burgos.

Exceptional evaluation:

The specific evaluation procedures will be determined according to the type of exceptionality of each student; nevertheless, in all cases, it will be necessary for students to develop some of the

non-recoverable activities of the subject (weight 20%). For the evaluation of the rest of the competences, oral (40% weight) and written (weight 40%) specific tests will be designed.

In the case of students who participate in the “Universitario Cantera” program, the grade will be determined based on the performance of the tasks assigned to them within the framework of the program.

Students must request in writing to the Dean of the Faculty of Science the possibility of availing themselves of the "exceptional evaluation" (see Article 9 of the UBU Evaluation Regulations).

The evaluation system for exchange students will be modified on the assumption that the academic calendars of the universities of origin and destination do not coincide.

3.3.4. LEARNING RESOURCES

Human resources:

Prof. Sagrario Beltrán, technicians of the BIOIND group laboratories and general human resources of the University of Burgos and specifically of the Faculty of Science.

Material resources:

Lectures will take place in the classroom where different teaching resources can be used: blackboard, digital board, projection of presentations and images from the computer by means of a projection cannon, etc.

The practical classes will be held in the laboratory of the BIOIND Group (Research Group recognized by the UBU, Industrial and Environmental Biotechnology) where students will become familiar with the equipment and pilot plants available to study processes that use presurized fluids.

The network resources available at the University of Burgos, both bibliographic resources (UBUcat catalog, databases, journals and electronic books, etc.) and the UBUVirtual platform (used to make information available to the students and to propose guided non-face-to-face and self-evaluation activities) will be used as supporting material.

3.3.5. CLASSROOM LANGUAGE

Spanish, and English when required