Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	**Reaction kinetics in food processing**
Course code	44704
Scientific sector	AGR/15
Degree	Food Sciences for Innovation and Authenticity
Semester	II
Year	I
Academic year	2023/2024
Credits	6
Modular	No

Total lecturing hours	36
Total exercise hours	24
Attendance	Yes
Prerequisites	Use of spreadsheet
Course page	

Specific educational objectives	**Aims** The goal of the course "Reaction Kinetics in Food Processing" is to provide students in the International Master's Program in "Food Sciences for Innovation and Authenticity" with a deep understanding of the chemical reactions that affect food quality during processing and preservation. The program includes theory, modeling and practical case studies, providing students with the knowledge and skills necessary to apply reaction kinetics to improve food stability, preserve food authenticity and innovate food processing technologies. Emphasizing hands-on learning and real-world applications, the course prepares for shelf-life estimation, optimizing food quality and extending food shelf-life with innovative approaches.

Lecturer	Matteo Mario Scampicchio
Scientific sector of the lecturer	AGR/15
Teaching language	English
Office hours	
Teaching assistant (if any)	PhD Yubin Ding
Office hours	
List of topics covered	**Part I: Reaction Kinetic Modelling** The course starts with a general background on the theory of reaction kinetics. The concept of rate equation and reaction mechanism is introduced together with key-terms, such as rates, rate constants and reaction orders. This part provides a

	solid background even to those students that have no knowledge on reaction kinetics. The part ends with a practical application dealing with thermal treatments of foods, and thermal death curve of microorganism. **Part II: Chemical Changes During Processing** In the second part, students are introduced into the degradation kinetics of major food components: carbohydrates, proteins, lipids, as well as vitamins and pigments. Practical examples, such as the Maillard reaction in crusts or lipid rancidity, help students understanding these concepts in real-world contexts. **Part III: Shelf Life** This last part is dedicated to food shelf life. This part starts with an overview of the controlling factors that govern food stability. Students are engaged with methodologies for shelf life studies, including accelerated shelf-life testing and their limitations. Case studies in this section provide practical insights into predicting and extending the shelf life of various food products.
Teaching format	Frontal lectures and exercices

Learning outcomes	The learning outcomes are: 1) **Understand Fundamental Principles of Reaction Kinetics:** Students will gain a solid foundation in the basic principles of reaction kinetics, including the theory of rates, rate constants, reaction orders, and the factors influencing these parameters in food systems. 2) **Apply Kinetic Models to Food Processing:** Students will be able to apply reaction kinetic modeling to predict and analyze quality changes in food during processing and storage, using integrated rate equations and understanding the impact of environmental factors like temperature, pH, and water activity. 3) **Analyze Chemical Changes in Food Components:** Students will comprehend the degradation kinetics of major food components such as carbohydrates, proteins, lipids, vitamins, and pigments during processing and how these affect food quality and nutritional value.

	4) **Conduct Shelf-Life Studies:** Students will acquire the skills to conduct shelf-life studies, including accelerated shelf-life testing, and apply these methods to predict the shelf life of various food products, understanding the limitations and practical applications of these studies. 5) **Evaluate the Effectiveness of Food Preservation Techniques:** Students will understand how reaction kinetic can be applied to evaluate the effectiveness of different food preservation techniques, including thermal treatments and hurdles technologies, in controlling microbial growth, enhancing food safety and quality, and extending food shelf life.
Assessment	The assessment consists of two parts: 1) a multiple-choice quiz 2) an optional written problem-to-solve case study. **PART I: Multiple Choice Quiz** The final exam includes a multiple-choice quiz, comprising questions that cover all aspects of the course content. This component contributes up to 24 out of a total of 30 points toward the final mark. **PART II: Written Problem-to-Solve Case Study** This second part involves the analysis of a real case scenario, such the changes occurring to a specific food during processing or storage. Typical tasks for this written part will include: • Describe the main degradation reactions based on the product description. • Draw the chemical components and main degradation pathways. • Determine the reaction order, justify the choice, and show calculations. • Calculate rate constants at varying temperatures with detailed calculations. • Estimate the activation energy, including full calculation process. • Predict the shelf life of the product and describe the methodology. • Analyze the effect of temperature on shelf life and product quality. • Interpret results, discuss quality and consumer acceptance implications, and suggest methods for shelf-life extension.

Assessment language	English
Evaluation criteria and criteria for awarding marks	The assessment will evaluate the student's ability to: • Apply theoretical knowledge from the course to solve practical problems related to food processing and shelf life prediction. • Precision in calculating rate constants, determining reaction orders, and estimating activation energy based on provided data. • Ability to analyze and interpret data, predict shelf life, and understand the impact of temperature on food quality. • Clear, concise, and well-structured responses, including necessary diagrams or graphs to support answers. • Ability to justify answers with theoretical knowledge from the course, demonstrating a deep understanding of reaction kinetics in food processing.

Required readings	During the lectures, students will receive slides for the general theories, electronic spreadsheets for the numerical applications and detailed instructions for the lab activities. This material is generally sufficient to be prepared for the exam. In addition, it follows a free of charge online book that describe the content of many lectures. Earle, R. Earle ,M., *Fundamentals of Food Reaction Technology* (free version online at: www.nzifst.org.nz/foodreactiontechnology/index.htm)
Supplementary readings	A comprehensive book on reaction kinetics in foods is the following. Feel free to find a copy in our Library and look through it: Martinus A.J.S. van Boekel, *Kinetic Modeling of Reactions In Foods*, (ISBN 9781574446142)