Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus

Course Description

Course Title	Reaction kinetics in food processing
Course Code	44740
Course Title Additional	
Scientific-Disciplinary Sector	AGRI-07/A
Language	English
Degree Course	Master in Food Sciences for Innovation and Authenticity
Other Degree Courses (Loaned)	
Lecturers	Prof. Matteo Mario Scampicchio, matteo.scampicchio@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-sciences/academic-staff/person/30226
Teaching Assistant	
Semester	Second semester
Course Year/s	1st
CP	6
Teaching Hours	36
Lab Hours	24
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	Reaction kinetics provides quantitative tools to describe, interpret, and predict chemical, biochemical, and microbiological changes in foods during processing and storage. The course covers the development of mechanistic thinking, from rate laws to process design decisions, with a focus on stability and shelf-life issues. Concepts are applied through computational exercises and case studies using food-relevant quality indices.
Course Topics	Thermodynamic drivers of change Rate concepts and kinetic in complex matrices Reaction mechanisms, rate laws and integrated forms: zero-, first-,

	and nth-order kinetics; half-life concepts; model selection Thermal processing kinetics Microbial inactivation Chemical changes during processing and storage Enzymatic browning: polyphenol oxidase pathways, oxygen limitation, thermal inactivation, colour endpoints. Maillard reaction kinetics Lipid oxidation: initiation–propagation–termination, Antioxidant reactivity Shelf-life modelling and study design Stability drivers: oxygen ingress, light exposure, water activity, microstructure, packaging permeability, storage stressors Accelerated shelf-life testing
Keywords	Reaction kinetics, Food degradation mechanisms, Temperature dependence, Lipid oxidation, Shelf-life modelling
Recommended Prerequisites	Topics covered include general chemistry, introductory food chemistry, basic calculus and elementary statistics. Familiarity with spreadsheet modelling would be an advantage (see the 'Computer Applications in Food Sciences' course in the first semester).
Propaedeutic Courses	None
Teaching Format	Teaching is delivered entirely in person. Asynchronous lecture recordings are available to support revision and individual study. Laboratory exercises are planned at NOI Park, together with at least one excursion to observe industrial-scale processing and quality control practices. Instruction includes working groups and a problem-based learning approach, supported by guided tutorials and case-study activities.
Mandatory Attendance	No
Specific Educational Objectives and Learning Outcomes	Knowledge and understanding: Deep understanding of the technological, microbiological, biochemical, chemical, and physical principles underlying food transformation processes and responsible for food product degradation, ensuring their stability and prolonging their shelf life. These knowledge areas will be developed through an educational program that integrates theoretical teaching activities with classroom tutorials, including examples, practical applications, individual and group work, and assessments aimed at encouraging active participation and independent solution development.

	These knowledge areas will be developed through an educational program that integrates theoretical teaching activities with practical activities, such as laboratory exercises, computer simulations, simulations of food processes using pilot plants, and company visits. Ability to apply knowledge and understanding: Ability to manage the technological, microbiological, biochemical, chemical, and physical processes that drive food transformation and the main issues related to the stability and shelf life of food products. Making judgements: Independent judgement is developed through a training programme designed to stimulate critical analysis in students. This includes the use of case studies, simulations using spreadsheets and videos, the reading and critical discussion of scientific articles, as well as specialist seminars held by experts in the food sector. The assessment of the independent judgement acquired by students is entrusted to the individual teachers responsible for the training activities, who will assess it through oral and/or written reports on specific topics and/or through exams. Communication skills: Use of the English language, both written and spoken, at a B2 level, with a command of technical and scientific vocabulary related to food science. Structure and draft scientific and technical documentation describing project activities. Interact and collaborate in the design and development of products and processes with peers and industry experts. The degree course provides graduates with the cognitive skills, logical tools and familiarity with new information technologies necessary to ensure continuous updating of knowledge, both in their specific professional field and in the field of scientific research.
Specific Educational Objectives and Learning Outcomes (additional info.)	A) Knowledge and understanding Upon successful completion, students may be able to: • Explain thermodynamic drivers of food change. • Describe core kinetic element for food reactions (rate laws,

	reaction order, rate constants, Arrhenius/Eyring temperature dependence). • Interpret key degradation processes relevant to food processing and stability, including enzymatic browning, Maillard chemistry, lipid peroxidation, antioxidant reactivity, and microbial inactivation. • Recognise how processing and physical factors (time–temperature history, mass transfer, microstructure, packaging permeability, catalytic metals, light) may modulate reaction rates and failure modes. B) Ability to apply knowledge and understanding Upon successful completion, students may be able to: • Formulate and solve kinetic models, including lethality metrics (D-, z-values) and quality retention under time–temperature profiles. • Estimate kinetic parameters from data using spreadsheets or simulations. • Design and interpret shelf-life studies, including accelerated testing. C) Making judgements Upon successful completion, students may be able to: • Critically evaluate kinetic models and literature, identifying assumptions, confounding factors (oxygen ingress, metal catalysis, phase partitioning). • Compare stabilisation strategies (radical scavenging, chelation, oxygen management) using case studies and simulation outputs. • Interpret kinetic results, including scenario definition, uncertainty bounds, and risk of shelf-life failure. D) Communication skills Upon successful completion, students may be able to: • Communicate kinetic and food-chemistry concepts in English at approximately B2 level, using appropriate technical vocabulary. E) Learning skills Upon successful completion, students may be able to: • Use digital tools (spreadsheets, simulation environments, literature resources). • Sourcing data, selecting endpoints, implementing simulations, and documenting limitations
Assessment	Mid-term exam (50%): in-person, kinetic foundations for Part I (thermodynamics, rate laws, reaction order, Arrhenius/Eyring,

	parameter estimation, basic non-isothermal integration, lethality descriptors). Final written exam (50%): in-person, scenario-based problems on stability and shelf-life.
Evaluation Criteria	Correctness of thermodynamic and kinetic concepts Mathematical correctness (for example, logarithmic linearisation). Unit consistency and dimensional analysis Model selection and assumptions Mechanistic interpretation consistent with food matrices Shelf-life reasoning Clarity of scientific communication
Required Readings	Lecture slides, spreadsheets (modelling templates), together with the lecturer's notes. Exercise notes distributed during tutorials and laboratory sessions. Earle, R. L.; Earle, M. D. *Fundamentals of Food Reaction Technology*. Royal Society of Chemistry, ISBN 978-1-904007-53-1.
Supplementary Readings	van Boekel, M. A. J. S. *Kinetic Modeling of Reactions in Foods*. CRC Press, Boca Raton, Two thousand eight. DOI: 10.1201/9781420017410.
Further Information	
Sustainable Development Goals (SDGs)	Zero hunger, Good health and well-being, Climate action, Responsible consumption and production, Industry, innovation and infrastructure