Syllabus

Course Description

Course Title	Measurements and Controls
Course Code	40460
Course Title Additional	
Scientific-Disciplinary Sector	
Language	English
Degree Course	Bachelor in Food and Enogastronomy Sciences
Other Degree Courses (Loaned)	
Lecturers	dr. Olga Nikoloudaki, Olga.Nikoloudaki@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-sciences/academic-staff/person/38535 Dr. Ksenia Morozova, Ksenia.Morozova@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-sciences/academic-staff/person/34748
Teaching Assistant	
Semester	First semester
Course Year/s	2nd
CP	6
Teaching Hours	36
Lab Hours	24
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	Module A: Measurements and regulations in fermentation (3 credits EN) The course is aimed at acquiring knowledge in the field of food safety microbiology, with reference to the hurdles that control microbial growth and to fermentation and starter cultures as a deliberate control strategy in their own right. It aims to provide knowledge on validating these controls quantitatively, from acidification, water activity and temperature to thermal and non-

	thermal inactivation, and on how fermentation is combined with the other hurdles through hurdle technology. Module B: Measurements and controls in food processing (3 credits EN) The module introduces analytical measurements used for monitoring food quality and food-processing operations. It focuses on the selection, application and interpretation of physicochemical and instrumental methods for food analysis, with particular attention to data quality, calibration, method performance and fitness for purpose. Students will learn how analytical measurements can be used to characterize raw materials, monitor changes during processing and storage, and support quality control decisions.
Course Topics	Module A: Measurements and regulations in fermentation (3 credits, EN) Food safety microbiology in foods, with emphasis on the principles governing microbial growth, survival and inactivation. Microbial growth requirements and the main preservation hurdles, including pH, organic acids, water activity, temperature, oxygen availability and antimicrobial compounds, will be examined in relation to their effects on foodborne pathogens and spoilage microorganisms. Fermentation will be considered as an intentional microbial control strategy, including the selection, characterization and performance of starter cultures and the role of acidification, metabolite production and competitive interactions in ensuring food safety and stability. Quantitative approaches for assessing and validating microbial controls will be introduced, including growth and inactivation kinetics, decimal reduction time (D-value), z-value, thermal resistance, and related concepts for evaluating process lethality. Students will examine the principles of thermal and non-thermal microbial inactivation and their application to food processing and fermentation. Particular attention will be given to the quantitative assessment of acidification and water activity as barriers to microbial growth, as well as to the interaction between individual hurdles. The module will also introduce hurdle technology as an integrated approach to food preservation, addressing how multiple mild preservation factors can be combined to achieve microbial control while maintaining product quality. Regulatory and food safety

	considerations relevant to fermented foods and processing conditions will be discussed, together with approaches for defining, monitoring and validating critical control parameters. Module B: Measurements and controls in food processing (3 credits, EN) Principles of analytical measurement in food science and food-processing operations, covering the selection and application of physicochemical, chemical and instrumental methods for the characterization and monitoring of food materials and processes. Measurements of key food properties, including pH, water activity, moisture, acidity, colour, texture and other relevant compositional and physical parameters, will be introduced in relation to product quality and process performance. Students will examine how analytical measurements can be applied at different stages of the food chain, from characterization of raw materials and ingredients to monitoring fermentation and processing, assessing changes during storage, and verifying final product quality. Instrumental analytical techniques will be introduced according to their measurement principles, applications, advantages, limitations and suitability for different food matrices. Particular emphasis will be placed on the quality and reliability of analytical data. Topics will include calibration and reference materials, measurement uncertainty, accuracy and precision, repeatability and reproducibility, detection and quantification limits, sources of analytical error, quality assurance and quality control. Students will learn to assess method performance and determine whether a method is fit for its intended purpose. The module will further address the interpretation of analytical results and their use in food-processing decisions, including process monitoring, identification of deviations, comparison of products or processing conditions, specification control and verification of quality and safety requirements. The integration of analytical measurements with process control and data-driven decision-making will be considered, with emphasis on selecting appropriate measurements and interpreting results in the context of the specific food process.
Keywords	Food safety microbiology; Fermentation; Starter cultures; Microbial growth and inactivation; Hurdle technology; Food processing; Physicochemical analysis; Instrumental methods; Process monitoring; Method validation; Measurement uncertainty; Quality

	control.
Recommended Prerequisites	
Propaedeutic Courses	-
Teaching Format	Teaching format includes frontal lectures and laboratory activities for both modules. Recording of module's B lectures is a possibility.
Mandatory Attendance	No
Specific Educational Objectives and Learning Outcomes	Upon completion of their studies, graduates with a bachelor's degree in Food and Enogastronomy Sciences will have acquired a solid foundation of scientific knowledge in disciplines such as chemistry, physics, biology, mathematics, computer science, and law, specifically applied to the food and gastronomic sector. They will gain technological skills for managing production and transformation processes, along with an integrated view of the quality, safety, and sustainability of food supply chains and systems. In addition, graduates will understand the principles related to waste reduction, resource optimization, and the reconciliation of economics and ethics, which are central elements for addressing the modern challenges of the agri-food system." The knowledge and understanding skills mentioned above are acquired through participation in lectures, practical exercises, seminars, and through guided personal study and individual study as provided by the activated educational activities. The verification of the achievement of learning outcomes is mainly carried out through exams and any interim tests. The tests may be written and/or oral, and may also consist of reports and oral presentations of projects or seminars. Students will be able to practically apply the knowledge they have acquired, developing the ability to solve complex problems in the food and gastronomic sector. Thanks to a wide range of practical activities, such as laboratories, internships, workshops, and seminars, they will be able to use chemical, physical, sensory, and microbiological analysis methods to evaluate the quality and safety of food and production processes. Graduates of the first profile will be able to manage food processing and preservation processes, design new technological solutions, and apply knowledge of plant genetics and process planning to ensure the quality of the final product. Graduates of

	the second profile will have advanced skills in managing restaurant businesses, promoting gastronomic heritage, and applying fermentation techniques and food design. In both paths, the ability to enhance by-products and reduce waste will be central, contributing to the sustainable innovation of the sector. The educational activities are designed to strengthen the autonomy of judgment and the ability to make decisions in complex contexts, as well as to develop communication skills and the ability to work in multidisciplinary and international teams. At the end of the program, graduates will be able to independently apply their knowledge in professional contexts, promoting innovative and sustainable solutions for the challenges of the agri-food and gastronomic system. The achievement of the ability to apply knowledge is accomplished through critical reflection on the texts proposed for individual study, stimulated by classroom activities, the study of research and application cases presented by the professors, the performance of practical laboratory exercises, fieldwork, bibliographic research, the completion of individual and/or group projects included in the core and elective courses of the curriculum, as well as during internships and the preparation of the final exam. The assessments, carried out through written and/or oral exams, reports, and exercises, involve the completion of specific tasks in which the student demonstrates mastery of tools, methodologies, and critical autonomy. During internships, the assessment is conducted through the presentation of a report by the student to the supervising professor. Evaluate and critically analyze the quality, safety, and sustainability of production processes and food products, considering scientific, technological, economic, and cultural aspects. Students will be able to make informed decisions based on scientific data and the analysis of production contexts to ensure the excellence of the final product. Apply ethical and sustainable approaches, reconciling economic needs with environmental and social requirements. Graduates will be able to identify solutions to reduce waste, enhance by-products, and optimize resource use, proposing food production models in line with the principles of the circular economy. Express independent judgments regarding innovative techniques for the transformation and enhancement of food and gastronomic

	productions, evaluating the risks and opportunities associated with the introduction of new technologies or business models, both locally and internationally. Interpret and manage complex data collected through chemical, physical, microbiological, and sensory analyses, in order to improve the quality of food products and effectively respond to food safety needs and regulatory requirements of the sector. "Communicate effectively and appropriately with both technical and non-technical interlocutors, including professionals in the food and gastronomic sector, public and private institutions, and the general public. This includes the ability to adapt the communication style based on the audience, using the specific technical language of the food and gastronomic sector when necessary. Present and discuss the results of their analyses and research in both written and oral form, using technological and multimedia tools. Graduates will be able to draft technical reports, research papers, and scientific documents, as well as present their results clearly and structured, for example during conferences, seminars, or business meetings. Actively participate in discussions and group work in multidisciplinary and international contexts, demonstrating active listening, negotiation, and collaboration skills. Practical experiences and internships will provide students with the abilities to work effectively in teams and contribute to solving complex problems in the sector. Use the three languages of instruction of the course (Italian, German, and English) fluently and confidently, both for written and oral communication. Thanks to the trilingual approach of the Free University of Bozen-Bolzano, graduates will be able to face international work contexts, participate in global networks, and contribute to the development of international cooperation projects to address the challenges of the food and gastronomic sector.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	The assessment will consist of a written examination (70% of the final mark) held at the end of the course and written laboratory reports (30% of the final mark).

	For Module A, the written examination will include multiple-choice questions, questions requiring the definition and explanation of key concepts, and a quantitative exercise involving the application of microbial growth and inactivation principles and related calculations. For Module B, the written examination will include questions assessing the understanding and interpretation of analytical measurements and food-processing controls, together with quantitative exercises requiring the application of relevant analytical and measurement concepts. The final grade will be the weighted average of the grades obtained in the two modules.
Evaluation Criteria	Students will be evaluated based on their ability to demonstrate understanding of the fundamental principles of food safety microbiology, fermentation and food processing; correctly apply relevant concepts and quantitative approaches to practical problems; interpret physicochemical and microbiological measurements; and critically evaluate analytical results and process-control parameters. Particular attention will be given to the accuracy of calculations, the correct interpretation of results, and the ability to select and justify appropriate methods and controls for specific food-processing and fermentation applications.
Required Readings	Module A: • Cocolin L., Gobbetti M., Neviani E. (eds.), *Microbiologia degli alimenti*, CEA Zanichelli, Milan, 2022, chapter 5 (Parente E., Ricciardi A., Zotta T., "Misure di controllo dei microrganismi negli alimenti," pp. 61 to 87). ISBN 978-88-08-12007-6. Module B: • Nielsen, S. S. (ed.). Food Analysis. Springer. • Nielsen, S. S. Food Analysis Laboratory Manual. Springer.
Supplementary Readings	
Further Information	
Sustainable Development Goals (SDGs)	Good health and well-being, Quality education, Responsible consumption and production, Industry, innovation and infrastructure, Decent work and economic growth

Course Module

Course Constituent Title	Measurements and Regulations in Fermentations
Course Code	40460A
Scientific-Disciplinary Sector	AGRI-08/A
Language	English
Lecturers	dr. Olga Nikoloudaki, Olga.Nikoloudaki@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-sciences/academic-staff/person/38535
Teaching Assistant	Dott. Dima El Janoudi
Semester	First semester
CP	3
Responsible Lecturer	
Teaching Hours	18
Lab Hours	12
Individual Study Hours	15
Planned Office Hours	9
Contents Summary	Module A: Measurements and regulations in fermentation (3 credits EN) The course is aimed at acquiring knowledge in the field of food safety microbiology, with reference to the hurdles that control microbial growth and to fermentation and starter cultures as a deliberate control strategy in their own right. It aims to provide knowledge on validating these controls quantitatively, from acidification, water activity and temperature to thermal and non-thermal inactivation, and on how fermentation is combined with the other hurdles through hurdle technology.
Course Topics	Principles of microbial control: biological risk, spoilage and fermentation as related phenomena, prevention and physical removal of microorganisms Control through acidification: pH and acidity of foods, the weak acid theory, industrial and fermentation-derived acidification Control through water activity: sorption isotherms, humectants, intermediate moisture foods Control through preservatives: natural and synthetic antimicrobials, bacteriocins, bioprotective cultures

	Control through temperature and packaging: refrigeration and the cold chain, freezing, modified atmosphere and active packaging Principles of microbial inactivation by physical treatments: decimal reduction time (D), thermal resistance constant (z), survivor curves Traditional thermal treatments: pasteurization, sterilization, UHT Non-thermal and emerging treatments: irradiation, high pressure processing, pulsed electric fields, cold plasma Hurdle technology and predictive microbiology tools
Teaching Format	The module consists entirely of frontal teaching: 18 hours of lectures delivered by the instructor covering the topics above, and 12 hours of laboratory activity, also instructor led, in which students carry out the four practical exercises of the module (pH and water activity mapping, thermal inactivation kinetics, hurdle challenge test with predictive software validation). The assessment will be administered as a written examination
Required Readings	Cocolin L., Gobbetti M., Neviani E. (eds.), *Microbiologia degli alimenti*, CEA Zanichelli, Milan, 2022, chapter 5 (Parente E., Ricciardi A., Zotta T., "Misure di controllo dei microrganismi negli alimenti," pp. 61 to 87). ISBN 978-88-08-12007-6.
Supplementary Readings	Masilamani S., Natarajan V., Radhakrishnan M., "Recent advances in nonthermal hurdle approach in the food sector," *Quality Assurance and Safety of Crops & Foods*, 2025, 17(2), 19 to 36. DOI: 10.15586/qas.v17i2.1515.

Course Module

Course Constituent Title	Measurements and Controls in Food Processing
Course Code	40460B
Scientific-Disciplinary Sector	AGRI-07/A
Language	English
Lecturers	Dr. Ksenia Morozova, Ksenia.Morozova@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-sciences/academic-staff/person/34748
Teaching Assistant	Dott. Milad Daneshniya
Semester	First semester
CP	3

Responsible Lecturer	
Teaching Hours	18
Lab Hours	12
Individual Study Hours	15
Planned Office Hours	9
Contents Summary	Module B: Measurements and controls in food processing (3 credits EN – profile food technology) The module introduces analytical measurements used for monitoring food quality and food-processing operations. It focuses on the selection, application and interpretation of physicochemical and instrumental methods for food analysis, with particular attention to data quality, calibration, method performance and fitness for purpose. Students will learn how analytical measurements can be used to characterize raw materials, monitor changes during processing and storage, and support quality control decisions.
Course Topics	1. Fundamentals of measurements for food quality control - Role of measurements in food processing and quality control - Representative sampling of food matrices - Introductory concepts of accuracy, precision and measurement variability - Basic principles of calibration, analytical range, LOD and LOQ for the interpretation of food-analysis results - Fitness for purpose of routine food-quality measurements 2. Physicochemical and compositional analysis of foods - Moisture, dry matter and total solids - pH, titratable acidity, conductivity and soluble solids - Determination of major food constituents, including proteins, lipids and carbohydrates - Reference and rapid methods used in routine food-quality control 3. Physical and rapid methods for food-quality assessment - Colour and optical measurements - Viscosity, rheology and texture measurements - Rapid and indirect methods for routine food-quality evaluation - Selected applications of chromatographic and spectroscopic

	techniques 4. Monitoring food processing and product quality - Chemical indicators of food deterioration and processing - Changes in physicochemical and quality parameters during processing and storage - Selection of suitable measurements for different food matrices - Interpretation of analytical results relative to product specifications and quality-control decisions - Integrated case studies on food-processing and product-quality monitoring
Teaching Format	The module combines lectures with practical laboratory activities, using worked examples, short data-interpretation tasks, method-selection exercises and case-based discussions. Laboratory sessions focus on calibration, comparison of analytical methods, and integrated evaluation of food quality using physicochemical measurements.
Required Readings	1. Nielsen, S. S. (ed.). *Food Analysis*. Springer. 2. Nielsen, S. S. *Food Analysis Laboratory Manual*. Springer.
Supplementary Readings	• Damodaran, S., Parkin, K. L. (eds.). *Fennema's Food Chemistry.* CRC Press. • Belitz, H.-D., Grosch, W., Schieberle, P. *Food Chemistry*. Springer.