PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

Higher School of Saharan Agriculture

El Oued

HIGHER SCHOOL OF SAHARAN AGRICULTURE - ELOUED

المدرسة العليا للفلاحة الصحراوية - الوادي

Academic Program

2nd Cycle

Agri-Food Technology

3nd Year

5th Semester

Teaching Unit (TU): FTU5.1

Course Title: Eco-processes and environmental assessment in agri-food industries

VHS: 67 h30 m (C/T)

Credits: 6

Coefficient: 3

Evaluation method: Continuous assessment: 40% Exam: 60 %.

Learning Objectives

- Understand environmental issues associated with agri-food processes.
- Identify sources of environmental impacts within food processing lines.
- Apply principles of eco-design and eco-processes in the agri-food sector.
- Master environmental assessment tools, particularly Life Cycle Assessment (LCA).
- Propose sustainable optimization solutions for production processes.

Course Content

Chapter 1: Environmental Issues in Agri-Food Industries

- Water consumption, energy usage, and waste generation.
- Typical environmental impacts of food industries.
- Regulatory frameworks (ISO 14000 series, European regulations, etc.).

Chapter 2: Introduction to Eco-Processes

- Definition and fundamental principles of eco-processes.
- Technological levers for impact reduction (mild processing, energy recovery, etc.).
- Examples of eco-innovations in food processing industries.

Chapter 3: Eco-Design of Processes

- Integrating environmental considerations from product/process inception.
- Tools and methodology for eco-design.
- Multi-criteria evaluation (quality, environmental impact, costs).

Chapter 4: Introduction to Environmental Assessment

- Objectives and principles of environmental evaluation.
- Distinction between mass/energy balances and environmental evaluation.
- Typology of assessment tools (LCA, carbon footprint, water footprint, etc.).

Chapter 5: Life Cycle Assessment (LCA)

- Definition and execution phases: goal and scope definition, inventory analysis, impact assessment, interpretation.
- Databases (Ecoinvent, etc.) and software tools (SimaPro, OpenLCA).
- Limitations and operational precautions.

Chapter 6: Industrial Case Studies

- LCA of a food product (e.g., yogurt, bread, beverage).
- Process optimization: reduction of inputs, valorization of co-products.
- Feedback and practical insights from Corporate Social Responsibility (CSR) projects in food industries.

Tutorial Sessions (TD)

TD 1: Environmental Diagnosis of a Process: Identify incoming and outgoing streams for a given process. Detect environmental critical control points (water, energy, waste).

TD 2: Study of an Eco-Innovative Process: Technical analysis of an eco-process (low-energy pasteurization, membrane filtration, etc.). Comparison with conventional processes.

TD 3: Introduction to Simplified LCA Software: Hands-on introduction to an LCA tool (demonstration in OpenLCA or SimaPro). Execution of a simplified LCA on a food product.

TD 4: Interpretation of LCA Results: Reading and critically evaluating an LCA report. Discussion on improvement levers within an agri-food system.

TD 5: Guided Group Mini-Project: Environmental Assessment: Carrying out a guided environmental analysis on a product or process. Oral presentation of findings and proposed improvement strategies.

Teaching Unit (TU): FTU5.1

Course Title: Advanced food process engineering

VHS: 67 h30 m (C/T)

Credits: 6

Coefficient: 3

Evaluation method: Continuous assessment: 40% Exam: 60 %.

Learning Objectives

- Master advanced principles of process engineering applied to agri-food industries.
- Analyze, model, and optimize complex unit operations.
- Apply mass and energy balances to equipment sizing.
- Understand and apply transport phenomena (heat, mass, momentum transfer) in food systems.
- Implement simulation and analytical tools to enhance process energy efficiency and sustainability.

Course Content

Chapter 1: Review and Fundamentals of Process Engineering

• Definition and scope of process engineering in food industries.
• Concept of system, process variables, steady and unsteady states.
• Overview of core unit operations.

Chapter 2: Advanced Transport Phenomena

• Heat Transfer: complex conduction, forced/natural convection, advanced heat exchangers.
• Mass Transfer: molecular diffusion, absorption, desorption.
• Momentum Transfer: pipe flow, pressure drops, fluid turbulence.

Chapter 3: Process Modeling and Simulation

• Differential equations applied to unit processes.
• Deterministic vs. empirical models.
• Utilization of simulation software (e.g., Aspen Plus, SuperPro Designer).

Chapter 4: Alternative Energies and Energy Efficiency

• Process energy balances.
• Energy saving strategies in food industries: heat recovery, insulation, cogeneration.
• Introduction to renewable energy integration (thermal solar, biomass, etc.).

Chapter 5: Complex Unit Operations

- Membrane separation techniques (reverse osmosis, ultrafiltration, nanofiltration).
- Drying and freeze-drying (lyophilization): critical mechanisms and parameters.
- Multiple-effect evaporation and extractive distillation.

Chapter 6: Process Optimization and Control

- Optimization techniques (linear and non-linear programming).
- Introduction to automated process control.
- Control loops, feedback schemes, and industrial sensors.

Tutorial Sessions (TD)

TD 1: Solving Complex Mass and Energy Balances: Application to multi-unit coupled processing plants (e.g., pasteurization + cooling).

TD 2: Unsteady-State Heat Transfer Analysis: Modeling fluid heating inside an agitated jacketed reactor. Solving basic differential equations.

TD 3: Heat Exchanger Sizing: Calculation of heat transfer surface area, effectiveness, and head losses. Selection of materials based on product constraints (heat-sensitive, viscous foods).

TD 4: Energy Audit of an Existing Industrial Process: Identification of thermal and electrical energy losses. Formulating concrete conservation and recovery measures.

TD 5: Comprehensive Case Study: Fruit Juice Concentration Process: Global system analysis: mass/energy balances, thermal transport, and process optimization toward sustainability.

Teaching Unit (TU): FTU5.2

Course Title: Predictive microbiology and new product development

VHS: 67 h30 m (C/T)

Credits: 6

Coefficient: 3

Evaluation method: Continuous assessment: 40% Exam: 60 %.

Learning Objectives

- Understand principles of predictive microbiology applied to food safety.
- Utilize mathematical models to predict microbial growth or inactivation.
- Identify factors governing contamination, survival, and proliferation of microorganisms in food matrixes.
- Apply predictive models in designing and validating novel food products.
- Formulate novel food products incorporating microbiological, nutritional, and technological dimensions.

Course Content

Chapter 1: Introduction to Predictive Microbiology

• Definition, significance, and application domains.

• Distinction between descriptive and predictive microbiology.

• Role in risk assessment and safety management.

Chapter 2: Factors Governing Microbial Behavior

• Intrinsic parameters (pH, water activity Aw, chemical composition).

• Extrinsic parameters (temperature, atmospheric composition, thermal/non-thermal treatments).

• Microbial interactions and hurdle technology (combined preservation techniques).

Chapter 3: Microbial Growth Modeling

• Primary models: Gompertz, Baranyi, Buchanan.

• Secondary models: influence of environmental variables.

• Model limitations, validation protocols, and interpretation.

Chapter 4: Software Tools in Predictive Microbiology

• Overview of dedicated platforms: ComBase, Sym'Previus, PMIP.

• Practical application in food safety analysis.

• Critical evaluation of simulated predictive scenarios.

Chapter 5: Application to Novel Food Product Formulation

- Integrating predictive modeling outputs into product design.
- Selection of appropriate ingredients and processing parameters.
- Inbuilt microbiological safety by design.

Chapter 6: Regulatory Standards and Quality Integration

- Microbiological criteria applicable to food products.
- Integration within Hazard Analysis Critical Control Point (HACCP) systems.
- Regulatory compliance requirements for commercial market authorization.

Tutorial Sessions (TD)

TD 1: Microbial Growth Kinetic Modeling: Estimation of kinetic parameters from empirical data. Fitting primary growth models (e.g., Gompertz).

TD 2: Environmental Factor Impact Study: Analyzing the influence of temperature or pH on pathogenic growth. Formulating simple secondary models.

TD 3: Practical Application of Predictive Software: Guided hands-on session using ComBase or Sym'Previus. Simulating diverse food storage and processing scenarios.

TD 4: Evaluation of Commercial Food Products: Microbiological diagnostic assessment of commercial food items. Hazard identification and formulation of control measures.

TD 5: Team Mini-Project: Novel Food Product Creation: Drafting technical specifications. Selecting ingredients, process parameters, packaging, and conducting microbiological validation. Oral presentation.

Teaching Unit (TU): MTU5

Course Title: Economics and management

VHS: 28 h30 m (C/T)

Credits: 2

Coefficient: 1

Evaluation method: Continuous assessment: 40% Exam: 60 %.

Learning Objectives

- Acquire fundamental concepts of economics applied to the agri-food sector.
- Understand market mechanisms and organizational behavior of enterprises.
- Identify economic dimensions of production, investment, and commercialization decisions.
- Grasp essentials of business management: accounting, cost analysis, profitability, and operational control.
- Analyze interactions between the macro-economic environment and corporate strategic management.

Course Content

Chapter 1: Fundamentals of Economics

• Definitions and major schools of economic thought.
• Concepts of human needs, scarcity, decision-making, and resource allocation.
• Key economic agents and their functional roles.
• Microeconomics vs. Macroeconomics.

Chapter 2: Market Dynamics and Mechanics

• Law of supply and demand.
• Market equilibrium, consumer surplus, and producer surplus.
• Market structures: perfect competition, monopoly, oligopoly.
• Market failures (externalities, public goods, information asymmetry).

Chapter 3: The Enterprise in the Economic System

• Corporate objectives and organizational functions.
• Factors of production and work organization.
• Productivity, returns to scale, and production optimization.
• Production costs (fixed, variable, average, marginal).

Chapter 4: Introduction to Financial Management

- Basic accounting: balance sheet, income statement, cash flow statement.
- Financial management principles: profitability, solvency, working capital.
- Cost accounting: prime cost calculation, break-even point analysis.
- Dashboards and key performance indicators (KPIs).

Chapter 5: Economic Strategy and Business Growth

- Corporate growth strategies: internal growth, diversification, technological innovation.
- SWOT analysis and Critical Success Factors (CSFs).
- Agri-food value chain management.
- Marketing strategies, distribution channels, and brand positioning.

Chapter 6: Agri-Food Economics and Contemporary Challenges

- Economics of agricultural and food commodity supply chains.
- Agricultural and food policies (CAP, international regulatory bodies).
- Sustainability, circular economy, and Corporate Social Responsibility (CSR).
- Current global economic trends: globalization, digitalization, inflation.

Teaching Unit (TU): MTU5

Course Title: Quality approach, accreditation, and certification in food processing

VHS: 31 h30 m (C/PW)

Credits: 3

Coefficient: 2

Evaluation method: Continuous assessment: 40% Exam: 60 %.

Learning Objectives

- Understand core principles of quality management within food processing industries.
- Identify and implement recognized quality standards, frameworks, and certifications.
- Master structural steps of establishing an industrial quality assurance program.
- Grasp laboratory accreditation procedures and system/product certification processes.
- Participate actively in setting up quality systems compliant with legal and normative mandates.

Course Content

Chapter 1: Introduction to Quality in Food Industries

• Definitions: Quality, Quality Assurance, Quality Control.

• Historical evolution: from end-product inspection to Total Quality Management.

• Strategic stakes and corporate benefits of quality systems in food processing.

Chapter 2: Quality Standards and Frameworks

• ISO Standards: ISO 9001, ISO 22000, ISO 17025.

• Private standards: BRCGS, IFS Food, FSSC 22000 — comparative analysis.

• Sector-specific standards and retailer specifications.

Chapter 3: Implementation of a Quality System

• Process mapping and organizational flowcharts.

• Quality manual, standard operating procedures (SOPs), work instructions, records.

• Quality performance indicators and continuous improvement tools (PDCA, Ishikawa 5M, FMEA/AMDEC).

Chapter 4: Laboratory Accreditation

• ISO/IEC 17025 standard: technical and management requirements.

• Metrological traceability, measurement uncertainty, method validation.

• Accreditation audits and role of national accreditation bodies (e.g., COFRAC, TUNAC, ALGERAC).

Chapter 5: Product and System Certification

- Voluntary vs. mandatory regulatory certification.
- Certification audit cycle: initial audit, reporting, surveillance.
- Official quality schemes and geographical indications (Organic, PDO/AOP, PGI/IGP, Label Rouge).

Chapter 6: Quality Auditing and Document Control

- Typology of audits: first-party (internal), second-party (supplier), third-party (certification).
- Audit planning, execution, non-conformity identification, and reporting.
- Document control systems and non-conformity management.

Practical Work Sessions (TP)

TP 1: Development of a Simplified Quality Plan: Constructing process maps for a fictitious food manufacturing plant. Drafting quality organizational flowcharts.

TP 2: Reading and Interpreting Quality Standards: In-depth analysis of excerpts from ISO 9001 or ISO 22000 standards. Identifying actionable requirements for industrial case scenarios.

TP 3: Internal Quality Audit Simulation: Audit preparation, checklist formulation, conducting simulated interviews, writing non-conformity reports and CAPA plans.

TP 4: Case Study: Agri-Food Product Certification: Mapping steps to achieve product certification (e.g., organic yogurt, specialty biscuit). Selection of standards and compilation of audit dossiers.

TP 5: Non-Conformity Tracking and Continuous Improvement: Recording and analyzing quality deviations. Developing Corrective and Preventive Action (CAPA) plans.

Teaching Unit (TU): MTU5

Course Title: Food risk assessment and management

VHS: 45 h (C/T/PW)

Credits: 4

Coefficient: 2

Evaluation method: Continuous assessment: 40% Exam: 60 %.

Learning Objectives

- Understand principles and terminology of risk analysis applied to food safety.
- Identify, evaluate, and characterize biological, chemical, and physical hazards in foods.
- Apply qualitative and quantitative risk assessment methodologies.
- Implement risk management systems (HACCP, PRPs, OPRPs).
- Analyze regulatory, institutional, and scientific mechanisms governing food safety.

Course Content

Chapter 1: Fundamentals of Food Safety Hazards and Risks

• Definitions: Hazard, Risk, Exposure, Dose-Response, Severity.

• Types of hazards: Biological (pathogenic bacteria, viruses, parasites), Chemical (pesticide residues, mycotoxins, heavy metals), Physical (foreign bodies).

• Fundamental objectives of food safety assurance.

Chapter 2: Principles of Risk Analysis Architecture

• Structured framework: Risk Assessment, Risk Management, Risk Communication.

• Codex Alimentarius approach and international methodologies (WHO, FAO, EFSA).

• Addressing limitations, variability, and uncertainty in scientific assessments.

Chapter 3: Food Safety Risk Assessment Methodologies

• Qualitative vs. Quantitative Risk Assessment (QRA).

• Dose-response modeling, exposure assessment models, and probability estimation.

• Computational tools and software supporting risk characterization.

Chapter 4: Operational Risk Management Tools

• Prerequisite Programs (PRPs) and Operational PRPs (OPRPs).

• HACCP System: principles, hazard analysis, establishing Critical Control Points (CCPs).

• Corrective action plans, validation, verification, and monitoring routines.

Chapter 5: Regulatory Framework and Institutional Governance

- General Food Law (Regulation EC 178/2002) and traceability principles.
- Roles of international and national agencies (EFSA, ANSES, FDA, etc.).
- Product recalls, emergency alerts, and food crisis management.

Chapter 6: Risk Communication and Public Perception

- Scientific communication vs. crisis communication.
- Consumer perception of technological and biological risks.
- Ethical and social responsibilities of food business operators.

Tutorial Sessions (TD)

TD 1: Analysis of Food Contamination Outbreaks: Case studies of real-world outbreaks (e.g., Salmonella, Listeria, STEC E. coli). Root cause analysis, consequences, and containment actions.

TD 2: Simplified Application of Risk Assessment: Constructing decision trees for specific food items. Evaluating risk profiles under varying processing scenarios.

TD 3: Development of a HACCP Plan Extract: Hazard identification across process flow diagrams. Setting CCPs, critical limits, monitoring procedures, and corrective actions.

TD 4: Interpretation of Regulatory Requirements: Analysis of food safety regulations and standards. Synthesizing legal obligations for food industry operators.

TD 5: Simulated Crisis Management Exercise: Scenario simulation: pathogen detection, product withdrawal/recall, press release, and public authority notification.

Practical Work Sessions (TP)

TP 1: Hazard Identification Across Production Lines: Analyzing processing flowcharts. Identifying biological, chemical, and physical hazards at each processing step.

TP 2: Qualitative Risk Matrix Development: Building a risk prioritization matrix for a selected food product. Classifying hazards by severity and likelihood.

TP 3: Application of HACCP Methodology: Drafting a functional HACCP plan. Identifying CCPs and establishing control parameters.

TP 4: Case Study: Health Crisis Management: Evaluating real-world food contamination events. Formulating response plans and stakeholder communication strategies.

TP 5: Simulated Sanitary Inspection: Auditing hygiene practices in a simulated food plant. Writing non-compliance reports and corrective recommendations.

Teaching Unit (TU): DTU5

Course Title: Food legislation and consumer law

VHS: 22 h 30 min (C)

Credits: 1

Coefficient: 1

Evaluation method: Continuous assessment: 100%

Learning Objectives

- Understand legal foundations governing consumer protection.
- Master major laws and regulations concerning food safety and consumer information.
- Identify rights and legal obligations of economic operators within the food chain.
- Analyze legal liability in instances of non-compliance or consumer harm.
- Grasp regulatory control mechanisms and consumer redressing pathways.

Course Content

Chapter 1: Introduction to Consumer Protection Law

• Definition, objectives, and scope of consumer law.
• Historical evolution of legal consumer safeguards.
• Legal sources: national legislation, European regulations, international standards.

Chapter 2: Fundamental Consumer Rights

• Right to safety, health protection, and hazard-free products.
• Right to comprehensive information: labeling, advertising accuracy, full traceability.
• Right to product choice, legal redress, and a healthy environment.

Chapter 3: Liabilities of Agri-Food Operators

• General duty of compliance and safety.
• Legal liability for defective products.
• Administrative penalties, civil remedies, and criminal sanctions.

Chapter 4: Specific Regulations in Agri-Food Sectors

• Key European regulations (Regulation EC 178/2002, 1169/2011 on food information, 852/2004 on hygiene).
• Rules on food hygiene, labeling, marketing claims, and traceability.
• Non-compliant products, adulterated goods, and mandatory recall protocols.

Chapter 5: Regulatory Oversight and Consumer Redress

- Role of regulatory authorities (sanitary inspectors, consumer protection agencies).
- Consumer advocacy associations and dispute mediation mechanisms.
- Filing complaints, judicial litigation, and out-of-court settlement procedures.

Chapter 6: Case Law and Legal Jurisprudence

- Analysis of judicial rulings concerning consumer disputes in food safety.
- Reviewing court decisions regarding food labeling fraud and safety breaches.
- Strategic impact of legal precedents on corporate policies.

Teaching Unit (TU): DTU5

Course Title: Food quality evaluation and management

VHS: 22 h 30 min (C)

Credits: 1

Coefficient: 1

Evaluation method: Exam: 100 %.

Learning Objectives

- Understand fundamental concepts of quality as applied to food products.
- Grasp multidimensional quality criteria: nutritional, sanitary, technological, and sensory.
- Identify analytical tools and methods for evaluating food quality.
- Analyze factors influencing quality throughout transformation processes and storage.
- Master quality management principles across the entire food supply chain.

Course Content

Chapter 1: Introduction to Food Quality Concepts

• Definition of food quality.

• Dimensions of food quality: microbiological/sanitary, nutritional, sensory/organoleptic, commercial.

• Consumer expectations, market trends, and quality perception.

Chapter 2: Food Quality Criteria and Attributes

• Physical Quality: texture, color, viscosity, appearance.

• Chemical Quality: proximate composition, moisture, food additives, contaminants.

• Microbiological Quality: beneficial flora vs. spoilage/pathogenic flora, shelf-life stability.

• Nutritional Quality: macronutrient balance, micronutrients, glycemic index, bioavailability.

Chapter 3: Quality Evaluation Methods

• Physicochemical analysis (pH, water activity Aw, dry matter, protein, lipid contents, etc.).

• Standard microbiological analytical methods.

• Sensory evaluation techniques: descriptive profiling and hedonic acceptance testing.

Chapter 4: Factors Governing Food Quality Variations

• Impacts of processing technologies (thermal treatment, refrigeration, fermentation, etc.).

• Influence of storage environment and packaging material interactions.

• Ingredient-process interactions and final quality attributes.

Chapter 5: Quality Management Systems in Food Operations

- Quality and safety assurance standards (ISO 9001, ISO 22000, HACCP).
- Traceability systems and document management.
- Quality performance metrics and KPIs.

Chapter 6: Quality Regulations and Official Controls

- Regulatory framework governing food quality.
- Mandatory labeling, nutritional declarations, and health claims.
- Official regulatory inspections and corporate internal control programs.

Teaching Unit (TU): TTU5

Course Title: Scientific bibliographic research and data handling

VHS: 22 h 30 min (C)

Credits: 1

Coefficient: 1

Evaluation method: Continuous assessment: 100%

Learning Objectives

- Acquire a rigorous scientific methodology for literature searching and review.
- Utilize scientific databases and bibliographic management software efficiently.
- Critically evaluate the reliability and scientific validity of published sources.
- Structure and author a comprehensive academic literature review.
- Master fundamentals of scientific data processing, analysis, and presentation.

Course Content

Chapter 1: Introduction to Scientific Literature Search

• Definition, rationale, and scope of scientific literature reviews.

• Types of scientific publications (peer-reviewed journal articles, theses, patents, conference proceedings).

• Distinction between primary and secondary literature sources.

Chapter 2: Search Strategies and Database Navigation

• Major scientific search engines and databases (ScienceDirect, Scopus, PubMed, Google Scholar, Web of Science).

• Formulating search queries: keywords, Boolean operators (AND, OR, NOT), search syntax filters.

• Setting up scientific monitoring tools and personalized research alerts.

Chapter 3: Bibliographic Reference Management

• Reference management software tools: Zotero, Mendeley, EndNote.

• Importing, organizing, indexing, and automated citation insertion.

• Citation styles and formatting guidelines (APA, Vancouver, ISO 690, Harvard).

Chapter 4: Critical Evaluation of Scientific Sources

• Quality metrics and source credibility assessment.

• Journal Impact Factor (JIF), h-index, indexing status, identifying predatory journals.

• Critical reading strategies and synthesis techniques.

Chapter 5: Structuring Literature Reviews and Scientific Reports

- Standard academic structure: Introduction, Thematic Sections, Critical Discussion, Conclusion.
- Academic writing style: clarity, precision, objectivity, scientific tone.
- Ethics in research: avoiding plagiarism and properly attributing intellectual property.

Chapter 6: Fundamentals of Scientific Data Processing

- Data types and variable classification (qualitative, quantitative, discrete, continuous).
- Descriptive statistics: measures of central tendency (mean, median) and dispersion (variance, standard deviation).
- Data visualization: charts, histograms, tables, scatter plots.

Chapter 7: Software Tools for Data Analysis

- Practical introduction to analytical software (Excel, SPSS, R, Python data libraries).
- Data cleaning, transformation, and structural preparation.
- Basic statistical interpretation and reporting of research findings.