



Food Quality Management and Chemistry of Natural Products

Organized by

Mediterranean Agronomic Institute of Chania

Food Quality Management and Chemistry of Natural Products

Scientific coordinator : DR. Panagiotis Kefalas

MAI Coordinator: Mr Alkinoos NIKOLAIDIS

Objectives

The Master on Food Quality Management and Chemistry of Natural Products provides a two-year programme for graduates holding a University Bachelors' degree in Chemistry, Agriculture, or other related sciences.

In the first year participants follow the Postgraduate Specialisation Programme. The objectives of this programme are to: i) provide advanced knowledge in the areas of food chemical composition and food microbiology; ii) introduce indispensable notions of quality and safety in all levels of production of food or other products; iii) present current advances for the isolation, characterization and application of natural products in the industry; iv) provide laboratory experience in food and natural product analysis; v) merge quality assurance requirements with the development, processing, preservation and packaging of edible products.

Laboratory exercises combined with these courses provide a practical and tangible perspective. The qualified first year graduates are entitled of pursuing their research in an environment fully equipped with the most updated facilities.

In the second year, students who have successfully completed the first year develop a thesis based on research leading to a Master's of Science degree.

The scientific results of graduate studies are usually announced in International Conferences and/or published in International Peer Review Scientific Journals.

Part I

Post graduate specialisation programme

The programme is organized in 4 sections

Tools ENGLISH, COMPUTERS

It includes introductory courses on Scientific English, use of Computer and Statistics.

Section 1 FUNDAMENTAL OVERVIEWS

The section intends to strengthen the background of the students in order to form a solid base, upon which the rest of the course will be based. It includes: an overview of organic and analytical chemistry and the indispensable statistics and uncertainty evaluation as tools.

Section 2 ADVANCED FOOD CHEMISTRY

The section is devoted to a detailed study of advanced themes in food chemistry and chemical analysis. The very important topic, nowadays, on functional foods is included, together with food microbiology.

Section 3 CHEMISTRY OF NATURAL PRODUCTS

The section focuses on the chemistry of natural products, as viewed through the study of specific families (alkaloids, terpenoids, flavonoids) and the laboratory techniques used for their isolation, identification and analysis. Their biosynthetic and metabolic paths are also included.

Section 4 TOPICS IN FOOD SCIENCES

The section focuses on other aspects of food production with reference to safety, preservation, quality assurance, legislation and chemical approach to the identification of specific origin.

TRAINING SEQUENCE

Tools

October

ENGLISH, COMPUTERS

Unit 1 – Scientific english (3 ECTS),

Unit 2 – Introductory computing (1 ECTS),

Section 1

(9 ECTS)

October - November

FUNDAMENTAL OVERVIEWS

Unit 1 – Statistical procedures (3 ECTS).

Unit 2 – Organic chemistry (3 ECTS),

Unit 3 – Analytical chemistry I (3 ECTS).

Section 2

(18 ECTS)

November - December

ADVANCED FOOD CHEMISTRY

Unit 1 – Foods/Lipids/Antioxidants (3 ECTS),

Unit 2 – Water relations in food – Food carbohydrates (3 ECTS),

Unit 3 – Food microbiology (3 ECTS),

Unit 4 – Food proteins and enzymes (3 ECTS),

Unit 5 – Analytical chemistry II (3 ECTS),

Unit 6 – Functional foods and bioactive ingredients (3 ECTS).

Section 3

(15 ECTS)

January - March

CHEMISTRY OF NATURAL PRODUCTS

Unit 1 – Biochemistry of secondary metabolism (3 ECTS),

Unit 2 – Chemistry of terpenoids and essential oils (3 ECTS),

Unit 3 – Chemistry of alkaloids, flavonoids and other phenolics (3 ECTS),

Unit 4 – Laboratory techniques I (3 ECTS),

Unit 5 – Laboratory techniques II (3 ECTS).

Section 4

(18 ECTS)

March - May

TOPICS IN FOOD SCIENCES

Unit 1 – New concepts in food packaging (3 ECTS),

Unit 2 – Trends in food processing-preservation technologies (3 ECTS),

Unit 3 – Food product development and predictive modelling of food quality (3 ECTS),

Unit 4 – Food legislation (3 ECTS),

Unit 5 – Products of appellation of origin (3 ECTS),

Unit 6 – Quality assurance (3 ECTS).

Comprehensive oral or written examination (Modalities and dates)

During Introduction, participants attend classes on English TOEFL and Computers. They are also obliged to attend a 45-hour course in Scientific English, equally distributed during sections, and take a written examination.

Participants take written examinations or submit projects for every unit within one section in the exam week which is scheduled at the end of every section, each unit being independently graded. Written exams consist of a set of questions that require a concise answer. Some of the questions are multiple choices. Lengthy questions are avoided.

Participants have the option of retaking course examinations of their preference equivalent of 9 ECTS credits during a weeklong retake period. There is no retake examination period for the last section.

A comprehensive oral examination conducted by an Examination Board takes place at the end of the academic year, representing 15% of the total grade.

Analytical syllabus

Tools

ENGLISH, COMPUTERS

Unit 1 – Scientific english

Note-taking skills in order to better understand lectures; the study of scientific texts and their development; terminology related to the students' chosen field; a review of the fundamentals of English grammar with a view to studying advanced grammar skills for the purposes of writing a M.Sc. thesis; development of academic writing skills; public speaking, communication skills and theme-related discussions based on the students' chosen field of study. The final grade is awarded on the basis of the following:

- examination marks (based on grammar and scientific texts);
- presentation marks (based on oral and written presentations of students' own work);
- participation in class work and attendance; homework assignments.

Unit 2 – Introductory computing

Computer hardware components, peripherals and controllers; architecture; operating systems. Interacting with computers. Data communications and computer networks. The Internet; brief history, protocols, addressing and domain name service (DNS). E-mail, News-Groups, Telnet, Ftp, WWW (World Wide Web). Computer applications; word processing, spread-sheets, data-bases, graphics, scientific software, schedulers. Computer Security.

Section 1 FUNDAMENTAL OVERVIEWS

Unit 1 – Statistical procedures

Descriptive statistics, frequency distributions measures of central tendency and dispersion. Probability distributions: Binomial, Hypergeometric, Poisson, Normal, X², Student-t and F. Statistical inference: estimation and hypothesis testing. Simple and multiple regression.

Unit 2 – Organic chemistry

Nomenclature, reactions, mechanisms, stereochemistry, asymmetry, families of compounds that are encountered in food chemistry, laboratory practice.

Unit 3 – Analytical chemistry I

Chemical equilibrium, buffers, complexes, titrations, redox potential, laboratory practice.

Section 2 ADVANCED FOOD CHEMISTRY

Unit 1 – Foods/Lipids/Antioxidants

Chemistry of oils and fats, free radical chemistry, reactive oxygen, photosensitised oxidation, metal catalysed reactions. Antioxidants: chemistry and mechanisms of action, techniques of evaluation of antioxidant activity, uses.

Unit 2 – Water relations in food – Food carbohydrates

Water relationships in foods: water activity and its relevance to deteriorative processes in foods (chemical, enzymic, physical and microbial changes). Glass transitions and molecular mobility in foods, their relevance to quality and stability of food products. State diagrams and strategies to enhance quality and shelf life of food systems. Food Carbohydrates: structural, analytical, physicochemical, nutritional and functional aspects of small mol. wt. carbohydrates and polysaccharides of plant and microbial origin.

Unit 3 – Food microbiology

Microbial growth in food: intrinsic, extrinsic and implicit factors. Microbial interactions. Inorganic, organic and antibiotic additives. Effects of enzymes and other proteins. Combination systems. Adaptation phenomena and stress phenomena. Effect of injury on growth or survival. Commercial available databases.

Unit 4 – Food proteins and enzymes

Chemistry and structure of food proteins, enzymic reactions, kinetics, Maillard reactions, enzymic browning.

Unit 5 – Analytical chemistry II

Special advanced topics on analytical chemistry. Introduction to Chemical instrumentation, basic components of analytical instruments, optical detectors (photomultipliers, monochromators, etc.), electrical detectors (pH-electrodes, etc), miscellaneous detectors. Atomic and molecular emission, absorption and fluorescence spectroscopy, Basic principles of analytical instrumentation used in Food Quality, Quality control of food and containers, migration of metals and compounds from container into food. Case studies.

Unit 6 – Functional foods and bioactive ingredients

Healthy natural foods, fortified foods, nutraceuticals, minerals, vitamins, phytosterols, polyphenols, phytoestrogens, ω -fatty acids, glucosinolates, non-digestible oligosaccharides, prebiotic cultures.

Section 3 CHEMISTRY OF NATURAL PRODUCTS

Unit 1 – Biochemistry of secondary metabolism

Introduction to plant metabolism. Plant structure and cell structure. Chemical nomenclature, the logic of metabolism and reaction mechanisms. Building blocks-biosynthetic pathways. Shikimate, mevalonate, methylerythritol phosphate pathway, glyceraldehyde-3-phosphate/ pyruvic acid pathway.

Important secondary metabolite groups: Fatty acids and polyketides, phenylpropanoids and lignin, terpenoids and steroids, tropane alkaloids, terpenoid indole alkaloids.

Gene regulation in secondary metabolism. Tissue specificity (phenylpropanoids) and stress responsiveness (terpenoid indole alkaloids). Compartmentation, storage and transport.

Unit 2 – Chemistry of terpenoids and essential oils

Fragrance and flavouring compounds : essential oils, terpenoids-oleoresins-Detailed biochemical pathways for the production of volatile compounds in specific plant species; Chemical structure, distribution, diurnal and seasonal fluctuations; Intraspecific differences in volatile oil production, differentiation between geographical origins; Turpentine and terpene industry and, biological activity).Raison d'être.

Unit 3 – Chemistry of alkaloids, flavonoids and other phenolics

Pharmacological action of alkaloids : Pyridine-piperidine alkaloids, Tropane alkaloids, quinoline alkaloids, isoquinoline alkaloids, indole alkaloids, imidazole alkaloids, steroidal alkaloids. Detailed biochemical pathways for the production of alkaloids in specific plant species. Chemical structures, subcellular localization, distribution and evolution in gymnosperms and angiosperms, biological activity & role of alkaloids in plants.Detailed biochemical pathways for the production of flavonoids in specific plant species. Chemical structures, subcellular localisation, natural distribution and evolution in gymnosperms and angiosperms. Biological activity: role of flavonoids in plants, Natural pigments:anthocyanins-flavonoids-other phenolic compounds and other miscellaneous natural pigments.

Unit 4 – Laboratory techniques I

Theory of chromatography, instrumental techniques (GC, HPLC) and applications, principles of mass spectroscopy and applications (LC-MS, GC-MS), principles of photospectroscopy, other spectroscopic methods (IR, NMR), identification, quantitation, structural determination, laboratory exercises.

Unit 5 – Laboratory techniques II

Theory of chromatography, instrumental techniques (GC, HPLC) and applications, principles of mass spectroscopy and applications (LC-MS, GC-MS), principles of photospectroscopy, other spectroscopic methods (IR, NMR), identification, quantitation, structural determination, laboratory exercises.

Section 4 TOPICS IN FOOD SCIENCES

Unit 1 – New concepts in food packaging

Introduction–functions of packaging, glass packaging materials, metal packaging materials, electrolytic chromium-coated steel, aluminium, stainless steel, container making processes, paper packaging materials, plastic packaging materials. Interactions between packaging and food, aseptic packaging.

Unit 2 – Trends in food processing – Preservation technologies

Conventional and new developments in food preservation techniques in plant equipment: thermal processing, aseptic processing, microwave heating, low temperature preservation, atmosphere storage, food irradiation, high pressure processing. Quality characteristics and shelf life of foods: examples of degradation mechanisms, viscous and bakery products. Chemical changes during processing and storage of foods. Shelf life prediction. Case studies.

Unit 3 – Food product development and predictive modelling of food quality

Quality aspects and self life of foods: (i) Examples of quality degradation mechanisms in foods: liquid foods (fruit juices), semi-liquid and viscous food dispersions, pastry and bakery products; (ii) Chemical changes during processing and storage of foods. Nutritional bioavailability of food constituents. Modelling and prediction of quality loss and microbial growth in foods using kinetics; ASLT methodology, Time-Temperature-Indicators (TTI's) and their use in quality modelling, case studies. Principles in food product development; the R&D process of designing new products, creating prototypes and testing them.

Unit 4 – Food legislation

Concepts and trends in food legislation. International and federal standards: Codex alimentarius, ISO series, food safety in USA. Legislation in Europe: directives of the official journal of the EU, council regulations, food legislation in UK. Regulating methods for food analysis, case studies.

Unit 5 – Products of appellation of origin

Olive oil, wine, honey, mediterranean edible herbs – infusions, chemical aspects of the identity of products of appellation of origin, (geographical, botanical), chemical fingerprint, laboratory exercises.

Unit 6 – Quality assurance

Basic concepts and principles of quality management: The certification process, certification bodies, audit techniques. Quality assurance in laboratories, accreditation regulations and criteria, calibration and verification, calculation of uncertainty, case study.

Part II

Master of Science Programme

Research Project (9 month duration)

Requirement : 60 ECTS credits

Laboratory techniques (Related to the subject of the Master Thesis)

Research Subject Areas: (topics generally available for Master of Science thesis):

- Isolation, structural elucidation of various natural products.
- Antioxidants: isolation and screening for antioxidant activity.
- Added value products from cheap, renewable sources.
- Methodologies for the estimation of antioxidant activity and/or free radicals, peroxides.
- Model systems to study mechanisms of antioxidant activity.
- Toxicant residues in food.
- Chemical fingerprinting of food and drink products: authenticity, origin.
- Antifraud chemical methodologies.

INDICATIVE MASTER THESES REALISED WITHIN THE AREA

TITLE: An investigation on biocatalytic properties of an onion solid waste homogenate: an insight into flavonol oxidation mechanism (2008)

AUTHOR: Ali Osman, Syria

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Dimitrios Makris

TITLE: A study on the removal of phenolics from Olive mill waste water using a peroxidase-active homogenate from onion solid by-product (2008)

AUTHOR: Nada Barakat, Lebanon

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Panagiotis Kefalas

TITLE: Antioxidant behaviour of polyphenols mixtures in model systems and correlation with redox potential: Distinction of synergistic and/or prooxidant effects (2008)

AUTHOR: Mario Abou Samra, Lebanon

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Panagiotis Kefalas

TITLE: Oxidation of the selected hydroxycinnamate derivatives by the use of an onion solid waste homogeneate: Characteristics, mechanisms and products (2008)

AUTHOR: Ayman El Agha, Lebanon

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Panagiotis Kefalas, Dimitrios Makris

TITLE: Antioxidant activity – guided optimization of polyphenols from onion solid waste employing water / ethanol mixtures (2007)

AUTHOR: Zied Khiari, Tunisia

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Panagiotis Kefalas, Dimitrios Makris

TITLE: Extraction of antioxidant phenolics from fermented carob kibbles employing water-ethanol mixtures (2007)

AUTHOR: Melita Cavdarova, FYROM

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Giuseppe Alonzo, Dimitrios Makris

TITLE: Isolation and biological evaluation of metabolites from species of the genus *Laurencia*: *Laurencia glandulifera* (2006)

AUTHOR: Souheila Abbedou, Algeria

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Vassilios Roussis

TITLE: Modulation of quality characteristics of Gewurztraminer wine during post harvest tunnel drying of the grapes (2006)

AUTHOR: Lamia Chkaiban, Lebanon

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Panagiotis Kefalas, Fabio Mencarelli

TITLE: Carotenoid profile and antioxidant activity of Algerian date varieties (*Phoenix dactylifera*) at various stage of maturation (2006)

AUTHOR: Hafid Boudries, Algeria

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Panagiotis Kefalas, Damaso Hornero Mendez

TITLE: Flavonoid profile and antioxidant activity of nectar honey from various regions of Greece and Algeria (2006)

AUTHOR: Samia Mellaoui, Algeria

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Panagiotis Kefalas

TITLE: Evolution of the in vitro antioxidant behaviour of a model system containing quercetin and catechin: Plausible importance of major reaction products (2006)

AUTHOR: Turan Burcu, Turkey

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Panagiotis Kefalas, Dimitrios Makris

TITLE: From farm to table microbial quality of food. A proposed model in the area of Crete, with the use of microbiological risk analysis (2006)

AUTHOR: Emmanuel N. Kokkinakis, Greece

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: George Boskou

TITLE: Model oxidation of quercetin: Isolation of two major oxidation products and evaluation of their antioxidant properties (2006)

AUTHOR: Aytac Gulsen, Food Engineer, Turkey

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Dimitrios Makris

TITLE: Testing algorithms using fatty acid methyl esters and triglyceride analyses to determine the authenticity of various vegetable oil blends (2005)

AUTHOR: Ariela Ferra, Food Chemist, Albania

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Chania, Greece

THESIS DIRECTORS: Maria Tsimidou

REFERENCES OF THE MAIN ACADEMIC STAFF TEACHING WITHIN THE M.SC.

More than 20 invited lecturers from about 5 countries participate in each edition of the M.Sc. programme of which, 26% came from Research Institutes, 62% from Higher Education Institutions, 12% from Private Companies.

AUSTRIA

Higher Educational Institutions

- Johannes Novak. Veterinary University of Vienna, Vienna

CANADA

Private companies

- Jerzy Zawistowski, Functional Foods and Nutraceuticals. Forbes Medi-Tech Inc, Vancouver

GREECE

Higher Education Institutions

- Athanasios Papadopoulos, University of Crete, Rethymnon
- Antonios Calokerinos, University of Athens, Athens
- Dimitrios Boskou. Aristotle University of Thessaloniki, Thessaloniki
- Konstantinos Biliaderis, Aristotle University of Thessaloniki, Thessaloniki
- Effie Tsakalidou, Agricultural University of Athens, Athens
- Vassilios Roussis, University of Athens, Athens
- Evgenios Kokkalou, Aristotle University of Thessaloniki, Thessaloniki
- George Boskou, Charokopio University, Athens
- Maria Tsimidou, Aristotle University of Thessaloniki, Thessaloniki
- Micheal Koupparis, University of Athens, Athens
- Ioannis Arvanitoyannis, University of Thessaly, Volos

Research Institutes

- Anastasia Detsi, Technical University of Athens, Athens
- Dimitrios Makris, National Agriculture Research Foundation, Athens

LEBANON

Higher Education Institutions

- Zeina Kassaify, American University of Beirut, Beirut

SPAIN

Research Institutes

- Damaso Hornero-Mendez, Instituto de la Grasa, CSIC, Sevilla