TEACHING GUIDE

# PHYSICOCHEMICAL PROCESSES OF INTEREST IN FOODS

**Academic Course 2017-2018**

(Last updated: 30/04/2015)
(Approved by Department Council: 21/06/2017)

| MODULE | SUBJECT | COURSE | SEMESTER | CREDITS | TYPE |
|---|---|---|---|---|---|
| 8 | PHYSICOCHEMICAL PROCESSES OF INTEREST IN FOODS | 4º | 2º | 6 | Optional |

| PROFESSOR | TUTORING CONTACT INFORMATION |
|---|---|
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| | **TUTORING HOURS** |
| | Monday: 8'00-10'30 h (Department)<br>Wednesday: 8'00-10'30 h (Department)<br>Thursday: 8'00-9'00 h (Department) |

| DEGREE IN WHICH THE SUBJECT IS TAUGHT | OTHER DEGREES IN WHICH THE SUBJECT COULD BE TAUGHT |
|---|---|
| Food Technology Degree | |

**PREREQUISITES AND RECOMENDATIONS (IF THEY APPLY)**

- Basic knowledges in Mathematics, Statistics, General Chemistry, General Physic and Physical Chemistry are strongly recommended

**BRIEF ACCOUNT OF THE SUBJECT PROGRAMME**

• Physical chemistry foundatios on preservation and processing of foods
• Adsorption processes
• Kinetic mechanisms related to the food wastage
•Energy transfer in steady and non-steady processes
• Colloidal state. Rheology

**BASIC, GENERAL, TRANSVERSAL AND SPECIFIC COMPETENCES**

(from pages 143-144 of the VERIFICA document)

**Basic and General Competences**

- CB.1, CB.2, CB.3, CB.4, CB.5, CG.06, CG.07, CG.08, CG.09, CG.10, CG.11, CG.12, CG.13, CG.05, CG.01, CG.02, CG.03, CG.04, CG.14

**Specific and Transferable competences**

- CT.2, CE.1, CE.2

**DETAILED SYLLABUS OF THE SUBJECT**

THEORETICAL SYLLABUS:

- UNIT 1. **Introduction**: Food technology. Brief review of the concept, history and objectives. Physicochemical role in food technology. Fresh and processed foods. Deterioration of fresh foods. (1 hour)
- UNIT 2. **Water**: General aspects. The water in the human body and foods. Chemical and structural aspects. Water in nature. Water aggregation states. Water phase diagram. (2 hours)
- UNIT 3. **Air-water system**. Humidity: Transitions involving water vapor equilibrium: evaporation and sublimation. Phase equilibria for the system formed by pure water and for air-water systems. Absolute humidity. Saturation pressure. Relative humidity. Dew point. Hygrometer. (2 hours)
- UNIT 4. **Food thermodynamics**. Water activity: Basic concepts of classical thermodynamics: System, surroundings, equilibrium. Food as a thermodynamic system. Water in food. Dry, semi-wet, and wet food. Vapor-liquid equilibrium. Thermodynamic activity concept. Water activity in aqueous solutions related to relative humidity. Water activity in food. Water content measurement in food. Indirect, direct and complementary procedures. Karl-Fisher method. Near infrared spectroscopy. (3 hours)
- UNIT5. **Adsorption**: solid adsorption Phenomena: Fundamentals. Physisorption. Chemisorption. Langmuir adsorption isotherms. B.E.T adsorption isotherm. Limitations of the B.E.T isotherm. G.A.B Isotherm. Other empirical adsorption isotherms. Using the adsorption isotherms: relative humidity isotherms. State of water in foods. Differentiated zones in the activity water vs. relative humidity diagram. Hysteresis cycle in the food adsorption isotherms. Influence of temperature on the adsorption isotherms. (3 hours)
- UNIT 6. **Heat**. Basic concepts. First law of thermodynamics: Statement. Enthalpy. Heat capacities. Specific heats. Latent heat. Specific heat in food. Measures of specific heats: Differential Scanning Calorimetry. Thermochemical. Combustion heat. Constant-volume adiabatic calorimeter (2 hours)
- UNIT 7. **Energy Transfer**: Transport phenomena. Thermal conductivity. Fourier law. Steady and non-steady processes. Steady-state thermal conductivity. Conductivity in systems composed of several materials. Thermal conductivity in cylindrical geometries. Other energy transfer mechanisms: convection from a fluid. Heat transfer by conduction-convection. Heat transfer by radiation. Heat transfer in unsteady state. Convection heat transfer in laminar fluid. (3 hours)
- UNIT 8. **Food stability**: Principles of chemical kinetics. General processes affecting food stability. Chemical and biochemical alterations. Browning, rancidity. Food stability and water activity. Enzymatic hydrolysis and biological processes. Non-enzymatic browning. Lipid peroxidation. Free Radicals: Concept, generation of free radicals, oxygen-centered radicals. Basic mechanisms and kinetic treatment of lipid peroxidation. Maillard reaction. (4 hours)

- UNIT 9. **Sterilization**: Thermal Processing. Sterilization. Pasteurization. Other physical methods. Kinetic sterilization treatment. Thermal death time. Decimal life time dependence with respect to temperature. Heat death in non-isothermal conditions. Weibulliniano model. (3 hours)
- UNIT 10. **Freezing**. Freezing food: Historical aspects, description and objectives. Kinetic freezing of pure water. Cooling curves. Supercooled and glassy state for pure water. General characteristics of the glassy state. Change in the thermodynamic properties at the glass transition. Solid-liquid Phase diagram for two-component systems. Freezing Kinetics for liquid solutions with simple eutectic. Freezing food. Phase diagram for the solid-liquid equilibrium in foods. The glassy state transitions. Influence of freezing in food quality. Freeze time. Thawing. (4 hours)
- UNIT 11.-**Evaporation**. Theory. Mass and energy transfer. Factors affecting heat transfer. Effects on food. Dehydration. Dehydration stages. Drying curves. Effects of dehydration. Lyophilization. Effects of lyophilization. (2 hours)
- UNIT 12. **Mechanical properties**. Macroscopic motion of fluids. Viscosity. Laminar and turbulent flows. General rheology. Newtonian and non-Newtonian fluids. Time dependent behavior: thixotropy. (2 hours)
- UNIT 13. **Surfaces**. Interfaces: surface and interfacial tension. Adsorption in solution. Gibbs isotherm. Surfactants: Classification. (1 hour)
- UNIT 14. **Colloidal state**. Definition and classification. Colloidal stability. Emulsifiers and stabilizers. Food colloids. Foams. Emulsions. Formulation of emulsions. Food emulsions. Gels (2 hours)

PRACTICAL SYLLABUS:

PRACTICE 1. DETERMINATION OF FOOD COMBUSTION HEAT WITH A BOMB CALORIMETER.
PRACTICE 2. DETERMINATION OF THYAMPHENICOL IN HEN'S EGG YOLK.
PRACTICE 3. OBTAINING COOLING CURVES AND FREEZING POINTS.
PRACTICE 4. DETERMINATION OF PH AND TOTAL ACIDITY OF BEER
[...]

**BIBLIOGRAPHY**

FUNDAMENTAL BIBLIOGRAPHY::


- 1.- "Propiedades Físicas de los Alimentos Procesados y de los Sistemas procesados". Lewis, M.J. Editorial Acribia S.A. 1993
- 2.- "Termodinámica y cinética de sistemas alimento entorno". Martínez Navarrete, N.; Andrés Grau, A.M.; Chiralt Boix, A.; Fito Maupoey, P. Universidad Politécnica de Valencia. 1999
- 3.- "Introducción a la Bioquímica y Tecnología de los Alimentos". Cheftel, J.C. y Cheftel, H. Editorial Acribia, S.A. (1999)
- 4.- "Ciencia de los Alimentos". Potter, N y Hotchkiss, J. Editorial Acribia S.A. (1999)
- 5.- "Deshidratación de Alimentos". Barbosa-Cánovas, G y Vega-Machado, H. Editorial Acribia S.A. (2000)
- 6.- "Ciencia y Tecnología de los Alimentos" Geoffrey Campbell-Platt Ed. Editorial Acribia (2009)


COMPLEMENTARY BIBLIOGRAPHY:


- "Introduction to the Physical Chemistry of Foods". Christos Ritzoulis. CRC Press. 2013.
- "Physical Chemistry of Foods" Pieter Walstra. Marcel Dekker, Inc. New York. USA. 2003
- "Physical Chemistry of Food Processes, Volume I: Fundamental Aspects". Ion C. Baianu Ed. Chapman and Hall. England. 1992
- "Fisicoquímica". Levine I.N. 5ª Ed. Mac Graw Hill/Interamericana España. 2004. Madrid.
- "Química Física". Atkins y de Paula. Ed. Panamericana. 8ª Ed. 2006