Ecodesign for food packaging

UNIT 12: Testing of food Packaging

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After acquiring this unit, the student will be able to:

- To know the main requirements that are imposed on packaging materials
- Be informed about the testing methods for food packaging materials

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1. Overview

- Food packaging materials should be tested to ensure that they have the right properties in terms of gas permeability, water vapor and contaminants; mechanical properties and other physical properties; and the thickness of the main components and coating layers.Testarea pachetelor poate să aibă în vedere:

- Food safety,
- Packaging compatibility with food,
- Migration of material from packaging to food, shelf life,
- Barrier properties, porosity, package atmosphere, etc
- Special requirements for quality assurance, good manufacturing practice, HACCP [1] , validation protocols, etc

2. Laws and rules for food contact materials

Legislația generală pentru toate materialele care intră în contact cu produsele alimentare este asigurată de:

- REGULATION (EU) NO. COMMISSION REGULATION (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food products
- EU Regulation on Good Manufacturing Practices for materials and objects that come in contact with food products (CE) 2023/2006
- REGULATION (EU) NO. COMMISSION REGULATION (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food product

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2. Laws and rules for food contact materials II

Annex I to EC Regulation 1935/2004 includes the following materials that can come into contact with food

1. Active and smart materials
2. Adhesives
3. Ceramics
4. Cork
5. Rubber
6. Glass
7. Ion exchange resins
8. Metals and alloys
9. Paper and cardboard
10. Plastics
11. Typographical inks
12. Regenerated cellulose
13. Silicon
14. Textiles
15. Varnishes and film-forming products
16. Wax
17. Wood

Table 2. Only 5 out of the 17 food packaging materials that are in contact with food are regulated in the EU

Regulated	Non-regulated	Non-regulated with high priority
Ceramics	Cork	Paper and cardboard
Regenerated cellulose	Adhesives	Varnishes and film-forming products
Active and smart materials	Silicons	Printing inks
Plastics	Elastomers and tires	
Plastice reciclate	Glass	
Ion exchange resins	Metals and alloys	
Wood		
Textiles		
Wax		

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2. Laws and rules for food contact materials III

Declaration of Conformity:

EU legislation and EFSA guidance documents detail how to compile dossier for food contact applications and what type of scientific data and other information should be included.
http://www.efsa.europa.eu/en/applications/foodcontactmaterials/regulationsandguidance

Minimum requirements in the declaration of conformity for the chemical substances of food contact materials:

A. A.EFSA opinion on chemicals (if available)
B. B. Self-assessment of manufacturers and declaration of compliance and documentation on toxicological tests (in vitro and in vivo) in accordance with EFSA requirements for FCM
C. C. Assessment of compliance risk from other countries according to the guidelines and required data equivalent to EFSA requirements such as BfR (Germany) or FDA (USA).
D. D. Restrictions in other legislation, eg. whether chemicals are regulated as food additives, including purity and identity requirements.

Reg. 10/2011 provides migration limits for plastics as follows:

Global Migration Limits (OMLs):

- Materials and plastic objects do not transfer components in food simulants in quantities greater than 10 milligrams of total components released per m2 of contact surface (mg / dm2).
- Plastic materials and articles intended to come into contact with food intended for infants and young children do not transfer their components into food simulants in excess of 60 milligrams / kg (simulant)

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Reg. 10/2011 II

Specific Migration Limits (SMLs):

• Plastic materials and articles do not transfer their components into food in quantities exceeding the specific migration limits set out in Annex I. These specific migration limits are expressed in mg of substance per kg of food (mg / kg).

• For substances not subject to a specific migration limit or other restrictions in Annex I, a generic specific migration limit of 60 mg / kg

Annex I can be consulted at:
http://eur-lex.europa.eu/legal-content/RO/TXT/HTML/?uri=CELEX:02011R0010-20170519&from=EN

Regulation no. 10/2011 defines food simulants to be used and contact foods. These are:

• simulant A - 10% ethanol (solution v / v), for hydrophilic food
• simulant B - 3% acetic acid (mass / volume solution) for foods with a pH below 4.5
• simulant C - 20% ethanol (v / v solution) for alcoholic foods with an alcohol content of up to 20%
• D1 simulant - 50% ethanol (v / v solution), for oil and water mixtures with an alcohol content of over 20%
• D2 simulant - vegetable oil, with a specific fatty acid specific distribution, for fatty foods
• E-poly simulant (2,6-diphenyl-p-phenylene oxide), particle size 60-80 mesh, 200nm pore size for dry food testing.

3. Types of tests for materials that come in contact with foodproducts :

- **Migration tests**
- **Testing the physical properties of food packaging**

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4. Migration tests

- Migration is determined on the material or object or on a specimen taken from the material or object or a specimen representative of that material or object. Only those parts of the sample intended to come into contact with the food actually used are brought into contact with the food simulant or the food.
- The sample preparation must indicate the date and place of sampling, the type of sample (material, article, intermediate product, etc.), the information on the label, the number of samples taken, the size and size of each sample, the detailed description of the sample, the conditions of the sample transport and preservation of the sample, the reason for the sampling, the responsible person.
- Depending on the shape and dimensions of the material or object to be tested, the migration tests can be performed in four ways:
  - using a migration test cell,
  - by preparing a bag,
  - by total immersion and
  - by filling the packaging.

Global Migration (GM):

- All substances that can migrate (gravimetric analysis)
- Unit: mg / dm2 (excluding FCM for infants and children mg / kg food / food simulant)
- The overall limit is 10 mg / dm2 or 60 mg / kg. The measurement error is 2 mg / dm2 or 12 mg / kg for food simulants A, B, C, D1 and 3 mg / dm2 or 20 mg / kg for fatty food simulants D2.
- EU rules for plastics: EN-1186 series
- EU norms, Paper and cardboard intended to come into contact with food: EN 1104, EN 1230, EN 13676, EN 14338, EN 20187, (ISO 187: 1990), EN 645, EN 646, EN 647, EN 648, EN 9200.

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4. Migration tests II

Specific Migration (SM):

- The amount of a specific substance that migrates
- Unit: mg / kg

- Following the exposure phase, the substance (s) in question should be extracted from the appropriate food simulant or from the food and then identified and quantified using a method of analysis.
- The specific migration limits for certain substances are defined as undetectable at a detection limit of 10 µg (10-3 g), substances / kg of food (or food simulant).
- Analytical determination of migrants includes three main steps: extraction, sample cleaning if necessary and determination (mainly by chromatography).
- EU rules for plastics: 1310 series

5. Testing the physical properties of food packaging

Testing of food Packaging is carried out in accordance with ISO 2206 standard conditions. Standard test conditions: 23 ° C, 50% RH.

- **Thicknesses**. The thickness of a material is the perpendicular distance between the two surfaces of the material. There are many physical properties of the packaging material depending on the thickness, ex. The rate of water vapor transmission (Water Vapour Transmission Rate - WVTR) and the transmission Rate of gas (Gas Transmission Rate GTR) of a film is inversely proportional to the thickness (decreases with increasing thickness). Measuring instruments used for thickness measurement: micrometers, calipers or electronic devices of high precision (especially for films). Paper thickness is measured in inches, points of inches or in mm (1 point = 1/1000 of an inch); For films, the thickness is measured in microns, mils, or in the gauge (25 microns = 1 mil = 1/1000 of an inch = 100 gauge = 0.25 mm).

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5. Testing the physical properties of food packaging II

- **The paper density:** the paper density (also known as basic weight or grammage) is a term used in the pulp and paper industry to denote a measure of the mass of the product per unit of area for a type of paper or cardboard. The term "density" is not used in its traditional sense of mass per unit of volume."The paper density ", rather, it is a measure of the density of the surfaces thereof. The paper density can also be used to distinguish paper from cardboard as the cardboard usually has a grammage greater than 224 g / m2. Normally two ways of expressing the density of the paper is used:
  - Expressed in grams per square meter (g / m2), the paper density is, also, known as weight. This is the measure used in most parts of the world.
  - Expressed in terms of mass / weight on the number of sheets, it is known as the base weight. The convention used in the United States and several other countries using the paper sizes in the U.S. are the mass in pounds of 500 or in some cases 1000 sheets of paper (pounds of a ream 500 or in some cases 1000 sheets) from a certain size of the basic (raw, still uncut). The japanese paper is expressed as weight in kg of 1000 sheets.
- **Breaking strength:** the Test measures the ability of a sample of paper, cardboard, foil, film, laminate plastic, to withstand the pneumatic or hydraulic shock. For films, foils, laminates and papers, the pneumatic test is used. Heavy paper and cardboard are tested hydraulicly (kgf/cm2 or lbs /sq. inch). In many cases, it serves as a good index of the quality of manufacturing of packaging materials.
- **Resistance to tearing:** the Paper is tested for the properties of resistance to tearing in two ways: internal laceration: the force required to propagate a internal breaking is measured. Laceration edges: measure the force required to initiate a rupture. The test is done in both directions of the paper. Unit of measurement [mN (mili Newton)].

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5. Testing the physical properties of food packaging III

- The factor of rupture is calculated as tear strength per unit of the basis weight of the paper and expressed in mN / g / m2 or dm2. The factor of breaking = breaking strength / weight
- **Tensile strength:** the testing Process involves placing the sample test in the testing machine and then slowly extend it until breaking. During this process, it is recorded the elongation of the sample function of the applied force. The data is handled so as not to be specific to the geometry of the test sample. Measurement of elongation is used to calculate the elongation of the specific (modulus of elasticity), ε, using the following equation: $\varepsilon=\Delta L/L0=(L-L0)/L0$ where ΔL is the change in length of the sample, L0 is the original length of the sample and L is the final length. Force measurement is used to calculate the tensile stress, σ, using the following equation: $\sigma=F/A$ where F is the tensile force and A is the section of the nominal sample size. The machine does these calculations as the force, so that the data points can be included in a curve $\sigma = f(\varepsilon)$.
- **The tensile strength of a paper** is defined as the force applied parallel to the plane of the sample with width and length specified, which is loaded with a force in standard conditions. The test indicates the durability and usefulness of the paper in the packaging operations, such as, packaging, printing etc. Plastic films are tested normally at higher speeds of loading due to the higher extensibility. The curve of loading helps in locating the area of productivity of maximum packaging. It is measured in both directions: - the direction of the processing on the machine (MD – machine direction) and perpendicular to it (CD – cross direction). The unit of measurement is the [N. m – newton meter].
- **The index of paper tensile strength** (tensile index) is defined as the tensile strength relative to the basis weight of the paper [(N/m)/gf/m2] = [Nm/gf]
- **Resistance to fat:** Resistance to fats is measured by exposing a sample crisped in the fat that contains red dye. The time required for the red spot to appear on the unexposed side is a measure of this property.

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- The rate of gas transmission (GTR):

The transmission rate of the gas is determined normally by measuring the variation of pressure at constant volume. The amount of gas that flows through the film is calculated as the volume at NTP (temperature and normal pressure). GTR is an important property to estimate the efficiency of the packaging material or the resistance of the pack to the flow of gas and helps in selecting the materials of the barrier, mainly for foods sensitive to oxygen.

- **The rate of water vapor transmission (WVTR**): WVTR is a measurement of the amount of water vapor in grams which will permeate from one side of the film with a surface of one square meter in 24 hours, when the difference of relative humidity between the two sides is maintained at 90% and 37.8 ° C. this Property is important for estimating the efficiency of the packaging material or a packaging for the resistance to water vapour and is useful in the consideration of the selection of the materials of the barrier for the food hygroscopic.
- **Resistance to shock:** These tests are designed to measure the ability of plastics to resist breakage by shock.
- **Resistance to abrasion:** This test is designed to measure the ability to resist surface wear by friction. The procedure consists in grinding the sample with a wheel of abrasion standard for a determined number of revolutions and measuring the loss of weight of a sample.
- The equipment used in the tests of the materials of packing food prducts is very diverse, and the presentation and knowledge of this is beyond the framework of the course. Information on this can be found in the catalogues of the various manufacturing firms ex. http://www.worldoftest.com/packaging-testing or http://www.zwick.com.tw/zwick-tw/pdf/brochures/99_269_Kunststoffe_FP_E.pdf etc.

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Thank you!

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