Project-N° 2019-1-CZ01-KA202-061409

LEARNING SCENARIO
MODULE 2

BIO-PACKAGING
INTRODUCTION

COLOPHON

Authors

This module is part of the Learning Scenario *Bio-packaging*. It is developed in the framework of the European Erasmus + project "BioComp".
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Acknowledgments

We would like to thank Ms. Anna Papakonstantinou, VET Curricula development expert, for the critical reading and revision of this document and Mr. Michael Diaz for the final proof reading of the document.

PREFACE

The Learning scenario *Bio-packaging* has been developed as part of the Erasmus + project BioComp. In that project, the most relevant competences for professions in the sector "Bio-packaging" are analysed, described, and ranked. Based on these competences, this Learning Scenario has been developed for EQF-level 3-4. The focus is on technical competences. Please see https://navigator.biocompetences.eu/ for further information.

The *Bio-packaging* learning scenario addresses the topic of food for packaging (in a biobased economy (BBE) context) as presented and analysed in IO1 and the final competence ranking list which gives the following results:

Cultivation of Tomatoes *(in a BBE context)*

Nr	Competences	Ranking points
T1	Working in a greenhouse – identifying the instructions of climate control (light, heat, humidity)	Biomass production in BBE context (2)
T2	Cultivation of tomatoes – Identifying and monitoring the growing process and maintaining quality control	Biomass production in BBE context (2)
T3	Working in a greenhouse – identification and preparation of the soil and nutrition/water system and planting	Biomass production in BBE context (2)
T4	Working in a greenhouse – identification and management of biological pest control	Biomass production in BBE context (2)
T5	Harvesting tomatoes – Identification and management of harvesting of tomatoes and post harvesting activities	Biomass production in BBE context (2)
T6	Harvesting tomatoes – Identification of the plant and implementation of harvesting of the tomato plant	Biomass production in BBE context (2)

Cereal production *(in a BBE context)*

This is finalized as "cereal production" which is more general

Nr	Competences	Ranking points
C1	Harvesting rice/cereals – identification and management of harvest methods; estimation of by-products and biomass potential	Biomass production in BBE context (2)
C2	Energy uses – Identification of by-products for non-energy and energy uses	Biomass production in BBE context (2)
C3	Biomass evaluation – Identification of biomass as a by-product of the food production process that can be re-used	Biomass production in BBE context (2)
C4	Biomass production and management – identification of plan, organizization and performance of farming operation to grow	Biomass production in BBE context (2)

Packaging process

Nr	Competences	Ranking points
P1	Control of process – Identification and monitoring of manufacturing quality standards	Control of process (4)
P2	Ecological benefits – Identifying the benefits of **bio packaging**	Ecological benefits of bio-packaging (1)
P3	Production of **bio-packaging material** – identifying technological and chemistry responses: to know the process of fermentation and processing methods/types	Production of bio-based (or bio-packaging) material (3)

P4	**Biobased material** – Identifying physical and mechanical features/characteristic of biobased material	Production of bio-based (or bio-packaging) material (3)
P5	Production of **bio-packaging material** – identifying new packaging concepts	Production of bio-based (or bio-packaging) material (3)
P6	Quality control – identifying the testing procedures	Control of process (4)
P7	Control of process – Identifying the Standard Operating Procedures (SOP)	8,04
P8	Quality control – Identifying the test procedures and the ICT systems	7,99
P9	Production of bio-packing material – Identifying the technical features, benefits, and limits of bio packaging	Control of process (4)
P10	Logistics – Identification of potential manufacturing deadline pressure	7,81

The Bio-packaging learning scenario includes the production and supply of the initial biomass (cases: tomato and cereals), the production of the material suitable for packaging, and the technical characteristics of the bio-packaging products. The 20 identified competences derived from IO1 were evaluated according to the average values and its coefficient of variation and were grouped according to similar content wherever possible.

This Learning Scenario is based on these competences and has been developed for EQF-level 3-4. It has the following 6 modules:

1. Circular economy
2. **Introduction**
3. Ecological benefits of bio-packaging
4. Biomass production in BBE context
5. Production of bio-based material
6. Technical characteristics of bio-packaging

Module 2 provides a short theoretical background and definitions of the packaging features and the definition of bio-packaging. This will give us a general idea about the topic and help us to better define the structure of the course and the content that we will create. This will be revised by the members of the working group.

Apart from these 6 text documents, the scenario also has a trailer and a WIKI with background information. To support the teacher, didactic guidance is available. It can be used for all scenarios and also includes suggestions for learning activities to develop personal and transversal competences. For this guidance, see the *Pedagogical Guidelines* in the Navigator.

This project is focused on food. The central objective of this work is food packaging.

CONTENT

Module 2 contains the following topics:

1. Introduction: What is packaging?
2. Sustainable food packaging
3. Definition of Bio-packaging
4. Practical exercise
5. Quiz
6. Sources

1. INTRODUCTION

Packaging, connected problems, and the aspect of Circular and Biobased economy

This section will provide brief information on what packaging is, its main functions, and why its use is connected with significant environmental problems.

Packaging includes many different products and processes and has a central role in containing and protecting the product as it moves through the supply change. Finally, it is disposed by the consumer, which causes serious packaging waste problems.

What is Packaging?

Packaging contributes to delivery of products to consumers in perfect condition. There are a great variety of types, uses, materials, and functions of well-designed packaging.

"A well-designed packaging meets the requirements of the product while minimising economic and environmental impact of both the product and its package"
Source: EUROPEN

In other words, **Packaging materials** are the economic manner which contains, protects, preserves, and informs about the product and its constraints while taking into account the legal and environmental point of view and legislation (Cruz-Romero and Kerry 2008).

This module aims to give students a general idea about packaging uses and necessary definitions. Since the BioComp project focuses on food production in a biobased economic context, the Bio-packaging learning scenario will focus on food packaging as a function of sustainable development.

Introductory video about food packaging and the connected problems

https://www.youtube.com/watch?v=aTcMPy6L88E

Further related videos, as educational resources
https://youtu.be/HQTUWK7CM-Y; https://youtu.be/ju_2NuK5O-E
https://www.youtube.com/watch?v=1h-nQgmRLpE; https://youtu.be/cwTDvqaqPIM
https://www.youtube.com/watch?v=Yomf5pBN8dY;https://www.youtube.com/watch?v=vZTL1aE3oFs
https://www.youtube.com/watch?v=1qT-rOXB6NI; https://www.youtube.com/watch?v=d3WYoSJ8wHo

Main functions of food packaging:

In the food production process, packaging has an important role in containing and protecting food as it moves through the food chain. The main functions of food packaging, as an important category of packaging, are summarized below:

1. Protection
2. Promotion
3. Information
4. Convenience
5. Utilisation
6. Handling
7. Waste reduction

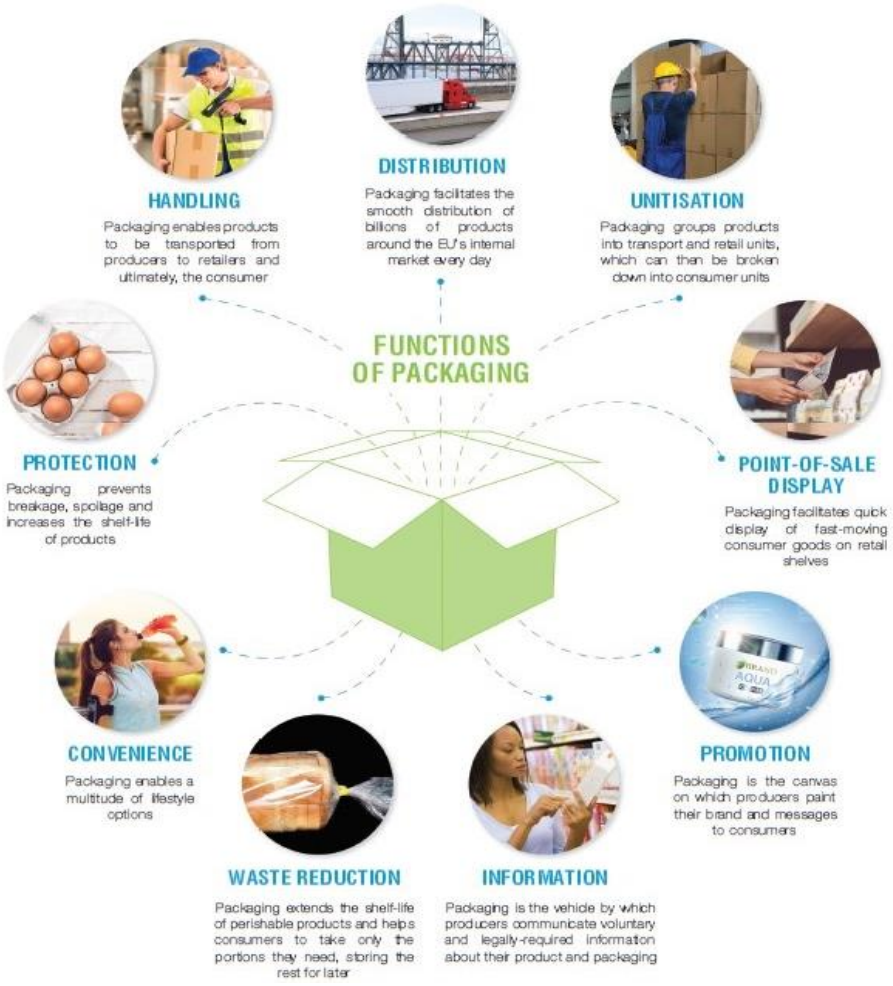

Figure 1. Summary of the main functions of packaging and food packaging

Source: https://europen-packaging.eu/sustainability/what-is-packaging.html

Environmental Problems connected with food packaging

Food packaging is connected with a big waste problem because traditionally, the packaging material is disposed of by consumers through the domestic waste channel causing contamination of natural resources and pollution. Additionally, in the last 50 years, the production of most of this packaging has become synthetic in nature and derived from fossil fuels that are a non-renewable resource (Miller 2005; Cruz-Romero and Kerry 2008).

Fossil-based plastics provide a majority of food packaging solutions; nevertheless, the production, use, and end-use of these materials are unsustainable because:

1. The production of fossil-based plastics contributes to greenhouse gas emissions (GHE);
2. Most food packaging has a short use-phase but takes more than 500 years to decompose;
3. Recent findings have shown that plastic doesn't disappear but breaks down into very small pieces (micro-plastic).

Figure 2. The waste problem - it takes a lot of time (more than 400 years) for some plastics to decompose. This is a lot of time. Do they just disappear?

The increasing problem of packaging waste has raised concerns for methods and materials that are more sustainable and can be used as substitutes, thus having less environmental impact.

2. SUSTAINABLE FOOD PACKAGING

Our world is facing global challenges connected to climate change, land and ecosystem degradation, a growing global population, and the optimum use of the limited available resources to secure food production while at the same time achieving sustainability and economic growth (EU bioeconomy strategy 2018). The key to facing all of these challenges is the improvement and innovation of the way we produce, consume, and re-use food, products, and materials within a healthy ecosystem as well as how we re-use these resources.

In the above framework, this concern is transferred to packaging and the need to find packaging solutions to develop sustainable food packaging in alignment with the Circular and Biobased economic concept.

Note: there is a lot of information regarding both the Circular and Biobased economies in the Algae learning scenario. There is no need to repeat them here. Instead, we will give only general definitions. For more information, please see the Algae *learning scenario.*

What is the Circular Economy?

*"The **circular economy** is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended."*

Source: https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits

In practice this means:

- ✓ Reduction of waste to a minimum
- ✓ Creation of added value
- ✓ A transition from the linear economic model (Take-Make-Consume-Throw away) towards a circular economic model (Re-use, Re-pair, Re-furbish, and Re-cycle existing materials and products).

What is the Biobased economy?

***"Biobased economy** refers to economic activity involving the use of biotechnology and biomass for the production of goods, services, or energy."*

This includes the application of scientific and technological developments to agriculture, health, chemical, and energy industries and focuses mainly on non-food goods. (https://en.wikipedia.org/wiki/Biobased_economy)

Sustainable Food Packaging in a Circular and Biobased Economic Context

The adoption of a circular and biobased economic concept is vital for the food packaging sector as is the necessity for sustainable packaging products made from **sustainable materials.**

"Sustainable biomaterials" are those that are: (1) sourced from sustainably grown and harvested cropland or forests, (2) manufactured without hazardous inputs and impacts, (3) are healthy and safe for the environment during use, and (4) designed to be reutilized at the end of their intended use such as via recycling or composting. (https://sustainablebiomaterials.org/).

The European Union recognized this problem and adopted in 1994 the EU Packaging and Packaging Waste directive (94/62/EC) as a set of rules for packaging and packaging waste in Europe. This Directive is reviewed every 10 years outlining the essential requirements for packaging.

Source: https://ec.europa.eu/environment/topics/waste-and-recycling/packaging-waste_en

Sustainably produced biomass that can used for the production of biomaterials is a major concern for stakeholders who are involved in this process (Guidelines for the Sustainable Biomaterials Collaborative, https://sustainablebiomaterials.org/).

Agriculture is an important source of biomass (among others) through crop production. Cereals and tomatoes are important crops cultivated in large areas which produce high quantities of biomass that are the source of starch (e.g. mainly from cereals, starch-based products), cellulose (e.g. tomatoes, cellulose based products), sugars, and oils.

For example, corn starch is a renewable raw material for the production of bioplastic which is 100% compostable.

In the following modules, more details will be provided about that.

3. WHAT IS BIO-PACKAGING?

Bio-packaging is a term in alignment with the context of the circular economy (as already mentioned, *please see the* Algae *learning scenario for more information regarding the Circular and Biobased Economies*).

Bio-packaging is a general term which includes many different categories of packaging materials that can be used in the packaging process in a biobased context. It includes the production of biobased materials with specific technical features that make them suitable (mainly) for food packaging use.

Biobased materials or bio-material are any material made from current living organisms (as opposed to non-renewable fossil fuels that are made from prehistoric plants), including agricultural species and residues, trees, and algae (https://sustainablebiomaterials.org/).

Biobased materials are materials that are wholly or partly derived from renewable sources and their source of origin and production process contributes to sustainable growth.

Biobased materials are classified into different groups according to different criteria such as the initial source of production (feedstock source) and the end-life (this will be analytically described in module 4 of the current learning scenario).

Biobased materials can serve as substitutes for fossil-based materials, their properties can vary from material to material and have suitable features for food packaging. https://www.plasticseurope.org/en/about-plastics/what-are-plastics/large-family/biodegradable-plastics

These materials are considered as biobased even if only one component is bio-based and not all of the material.

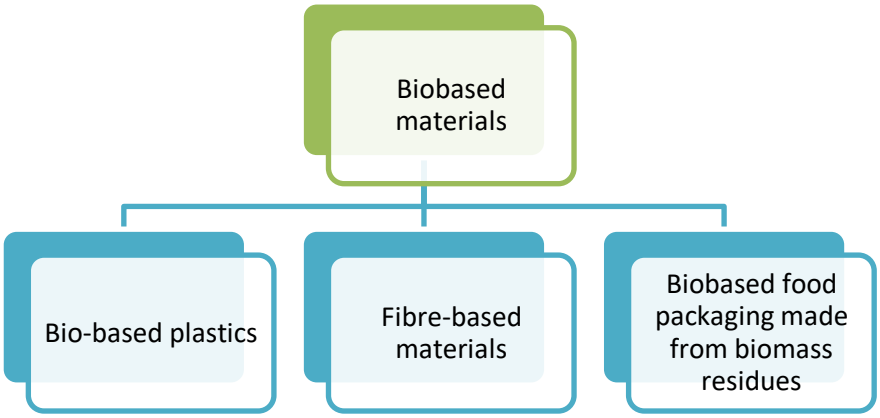

Figure 3. The different categories of bio-based materials suitable for food packaging (van Crevel, 2016).

Examples of bio-based materials

Figure 4. Examples of bio-based plastics: a) a scheme of bio-based plastic (bio-based PET) containing 25% of bio-based plastic with the rest consisting of traditional plastic, https://bioplasticsnews.com/2013/12/31/bio-based-pet/ , b) a bio-based plastic bag which looks like plastic but is 100% made from corn starch.

Figure 5. Example of fiber based bio-based materials (e.g. rice straw) for food packaging

Biobased materials suitable for food packaging

Biobased packaging materials will need to have similar functions and characteristics as traditional packaging materials and the already existing food packaging solutions. These functions are described at the beginning of the section.

Bio-based drop-in plastics such as bio-PE (biobased-PE) and bio-PET (biobased-PET) are identical to fossil-based counterparts and can be used in exactly the same applications. The three most commonly used bio-based plastics with unique properties are: 1) PLA, 2) Starch-based plastics, and 3) Cellophane.

At this point, we need to recognize some confusion around the term bioplastic. “Bioplastic” is a generic term. The prefix 'bio' may refer to, on the one hand, the **biological origin** of the material or, on the other hand, the **biological degradability** of the material. However, both aspects are not necessarily related. The issue of whether the material is degradable or not is important and connected with the environmental impact.

For example, bioplastic can be made from agricultural by-products and also from used plastic bottles using microorganisms (Wikipedia, https://www.alpagro.be/en/support/material-types/bioplastic/). A very typical example of a bioplastic that is 100% compostable are plastic bags made from corn starch (Fig. 4). Therefore, it is likely that the percentage of the biodegradability of a product is also important.

The above mentioned terms will be further analysed in the following modules of the Bio-packaging learning scenario - this is just a simple reference.

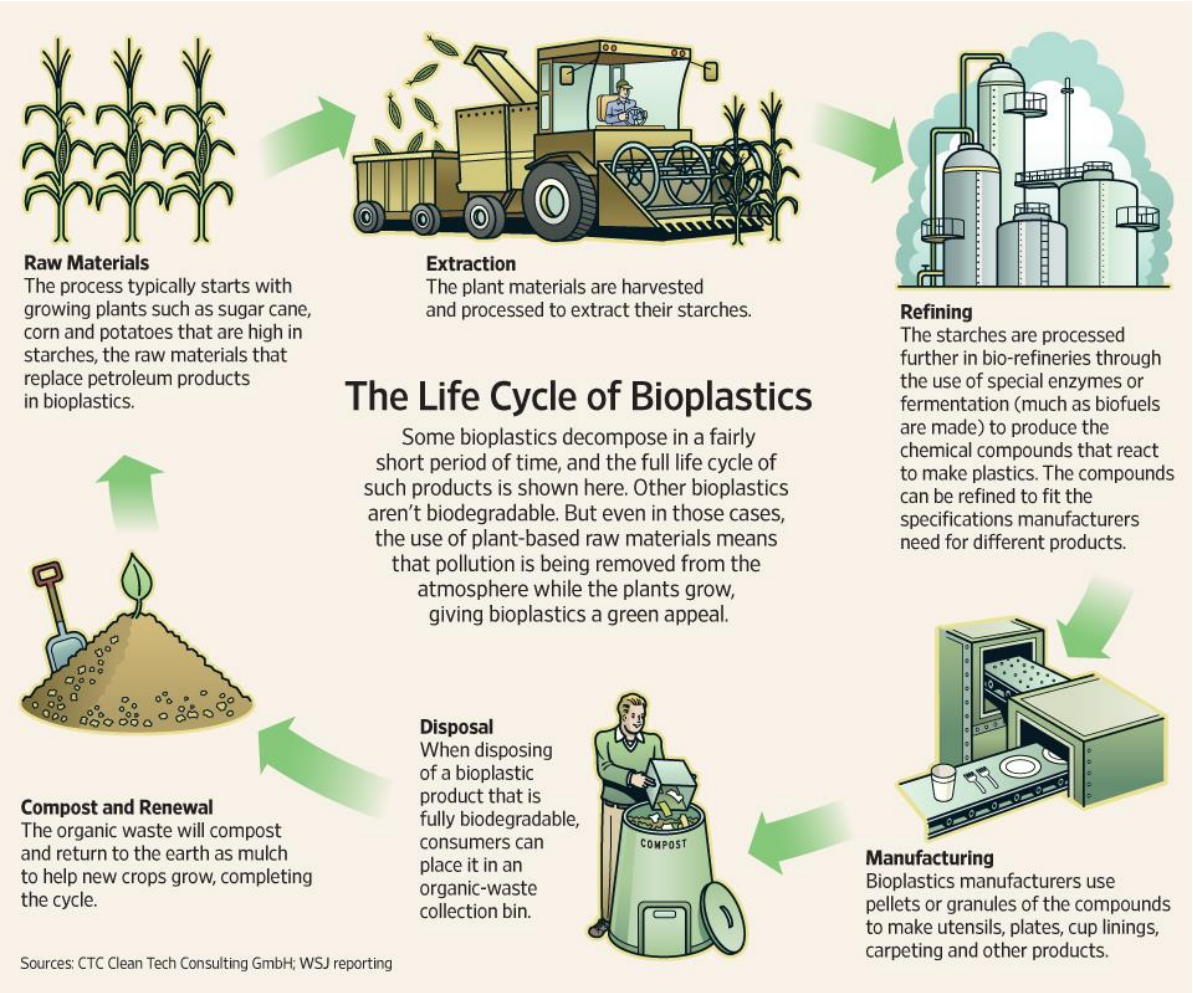

Figure 4. A typical example of bioplastic made from corn starch that is 100% compostable

Source: https://plasticpollutionblogsite.wordpress.com/2016/10/31/solution-technology-1/

4. PRACTICAL ACTIVITY/EXERCISE FOR STUDENTS

ACTIVITY 1: PRACTICAL EXERCISE

Each student collects 5 food packaging materials, takes a photo and identifies the different packaging features and materials.

Packaging (short description)	Photo	Features[1]	Material[2]	"Fate" after product use[3]
1.				
2.				
3.				
4.				
5.				

[1] Features: Product Protection, Promotion of the product, Information about the ingredients, Ease of use for the consumer, Waste reduction, Extension of the life of the product, other …. (Indicative answers)

[2] Materials: Plastic (PET or other), paper, wood, aluminium,

[3] "Fate" after the products' use: Re-use, Re-pair, Re-furbish, Re-cycle

5. QUIZ

ACTIVITY 2: QUIZ

1) **Important features of food packaging are:**
    a. Protect, inform, waste reduction
    b. Handle, sterile, cooking
    c. Inform, dehydrate, consume

    Correct answer: a)

2) **Moulded packages made from pulp or recycled raw material are:**
    a. 100% recyclable sustainable products
    b. with a long decay period
    c. important source of water pollution

    Correct answer: a)

3) **What is PLA?**
    a. plastic highly polluting nature
    b. compostable bioplastic
    c. a fertilizer

    Correct answer: b)

4) **Decomposition of traditional plastics can take:**
    a. more than 400 years
    b. up to 10 years
    c. in a few days

    Correct answer: a)

5) **The main advantages of using organic bags and packaging are:**

    a. reduction of environmental pollution
    b. lower financial costs for the manufacturer
    c. protection from drought events

    Correct answer: a)

6. SOURCES

Cruz-Romero M. and J. P. Kerry. 2008. Crop-based biodegradable packaging and its environmental implication. CAB Review

Miller R. The Landscape for Biopolymers in Packaging. National Non-Food Crops Centre (NNFCC) Publication, Heslington, York, UK; 2005.

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https://plasticpollutionblogsite.wordpress.com/2016/10/31/solution-technology-1/

https://europen-packaging.eu/sustainability/what-is-packaging.html

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https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits