



TOOLKITS

**The transformation of citrus waste in bioproducts.
Techniques, methodologies and technologies.**

CONTENTS

MODULE I. INTRODUCTION TO THE CITRUS WASTE VALORISATION	3
Introduction	4
Activity 1 – Agricultural production modes and quality certification	5
Activity 2 – Distribution Chain Operators and Waste Location	10
Evaluation Resources	18
MODULE II. METHODS AND VALORIZATION TECHNOLOGY EXTRACTION OF ESSENTIAL OILS AND THEIR USE	19
Introduction	20
EXTRACTION OF ESSENTIAL OILS BY SOXLET EXTRACTION	21
EXTRACTION OF ESSENTIAL OILS BY THE HYDRODISTILLATION METHOD	25
EXTRACTION OF ESSENTIAL OILS BY THE MACERATION PROCESS WITH ALCOHOL	27
CANDLE PRODUCTION	28
SOAP PRODUCTION	29
Evaluation	31
Module III - BIOPRODUCTS MARKET	32
Introduction	33
The Citrus Waste Valorisation	34
From Agriculture to rural business start up	38
Innovative Start up Ideas	39
EVALUATION	41

TOOLKITS

MODULE I. INTRODUCTION TO THE CITRUS WASTE VALORISATION

Edited By: Juan Manuel Cárdenas (EFA La Malvesia)

Introduction

The following presentation summarizes the concepts transmitted throughout Module 1. Transformation of citrus waste into bioproducts, with the intention of bringing these contents closer to students in a more attractive and visual way.

You can find the presentation in this [link](#).

Objectives and skills

The activities considered for this module have been designed with the aim of identifying the by-products derived from citrus production and the options for their management, both from an economic and environmental point of view.

To do this, it is necessary to bring students closer to the reality of the production models used in the citrus-growing, and the ways you can try throughout the distribution chain, until reaching the final client.

Thus, to achieve this general objective, the following secondary objectives and competences are worked on:

- Identification of the phases of the distribution chain
- By-product identification
- Knowing by-products use
- Environmental benefits or damages
- Language skills
- Group work
- Critical thinking

Activity 1. Agricultural production modes and quality certification

1 Objective:

The aim of this activity is to relate the different models of agricultural production with the images of characteristic types of farms and their logos.

AGRICULTURAL PRODUCTION MODES

- Integrated Production
- Super Intensive Orchard
- Organic Farming

LOGOS AND QUALITY CERTIFICATIONS

- Protected Geographical Indications (PGI)
- Organic Farming
- Integrated Production

TYPES OF PRUNING

- Pruning focused on productivity and efficiency of pesticide treatments
- Productivity focused pruning at the lowest cost
- Pruning used for pest and disease control

2 Resources and Materials

- ✪ Drawings about production models, types of pruning and certification logos.
- ✪ Foam board one side adhesive
- ✪ Magnets
- ✪ Double-sided adhesive tape
- ✪ Magnetic board
- ✪ Double-sided adhesive tape

▶ Images of the different production models of agriculture:



Source: Agricare



Source: Innovagri



Source: www.europa.eu



Source: www.europa.eu

▶ Pruning styles for citrus



Source: launion



Source: Universidad de Florida

3 Procedure

Relate each image to one of the productive models of agriculture, as well as the related logos and quality certifications. You also have to associate each style of pruning with the productive model of agriculture to which it belongs.

To do this, the following steps must be taken:

- ◆ Divide the class into several working groups.
- ◆ Cut out the photos provided and place them on supports with magnets so that they can be placed on magnetic boards.
- ◆ Divide the magnetic board into three zones: Integrated Production; Super Intensive Orchard; Organic Farming.
- ◆ Place each of the photos in the zone that is considered most appropriate for the style of pruning, cultivation or logo that reflects the photograph.
- ◆ Drive a discussion between the groups, arguing the way the photos distribution have been made.
- ◆ The teachers clarify any possible doubts and establish the correct distribution of the photographs in the different areas of the magnetic board.

Activity 2. Distribution Chain Operators and Waste Location

1 Objective:

The objective of this activity is to recognize the stages that affect the process of production, handling and distribution of citrus fruits, while identifying the points where the various by-products are produced.

2 Resources and Materials

- ✪ Supply Chain Flowchart Drawings
- ✪ By-products, types of management and their uses (economic problems in red, environmental problems in yellow and uses in green)
- ✪ Arrows to sequence the stages of the distribution chain
- ✪ Foam board one side adhesive
- ✪ Magnets
- ✪ Double-sided adhesive tape
- ✪ Magnetic board
- ✪ Double-sided adhesive tape

▶ Images of the different stages of the citrus distribution chain:

CITRUS SUPPLY CHAIN

PRODUCTION



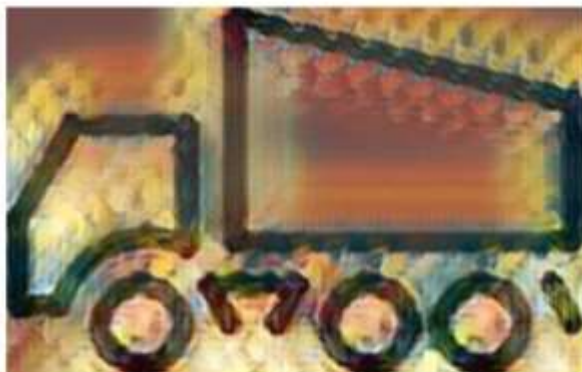
CITRUS SUPPLY CHAIN

PICKING



CITRUS SUPPLY CHAIN

TRANSPORT TO WAREHOUSE



CITRUS SUPPLY CHAIN

CONFECTION



CITRUS SUPPLY CHAIN



REFRIGERATED
TRANSPORT



CITRUS SUPPLY CHAIN

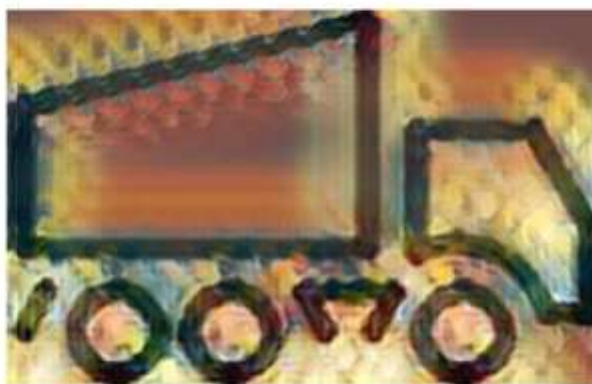


CENTRAL
DISTRIBUTION
FACILITY



CITRUS SUPPLY CHAIN

**REFRIGERATED
TRANSPORT**



CITRUS SUPPLY CHAIN

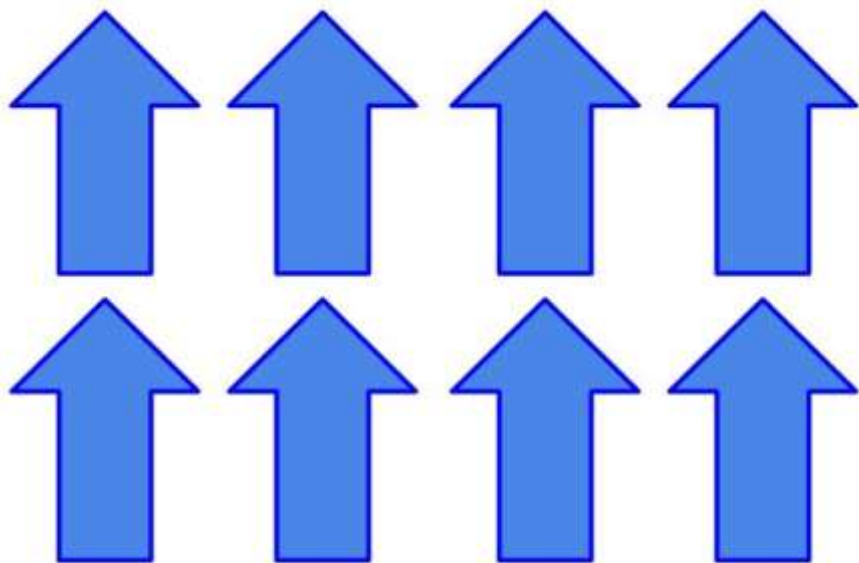
LOCAL MARKET



CITRUS SUPPLY CHAIN
SUPERMARKET



▶ Arrows to sequence the stages of the distribution chain:



▶ By-products, types of management and their uses (economic problems in red, environmental problems in yellow and uses in green):

CITRUS WASTE



NON-COMMERCIAL PRODUCTS



ANIMAL FEED



BY-PRODUCTS OF CITRUS JUICE

↳ **ANIMAL FEED**

↳ **ESSENTIAL OILS**

PRUNING WASTE



FIELD BURNING OF PRUNING WASTE



ORGANIC MANURE



ESSENTIAL OILS (from leaves)



PELLETS FOR ANIMAL FEED (from leaves)



PELLETS FOR BIOMASS (from wood)

3 Procedure

It builds a flow chart from the images representing the stages of the citrus distribution chain, indicating when by-products appear, and how they can be managed.

To do this, the following steps must be taken:

STAGE 1

- ◆ Divide students into several working groups.
- ◆ Cut out the photos provided and place them on supports with magnets so that they can be placed on magnetic boards.
- ◆ Place each of the photos in the correct order, building a flow diagram of the citrus distribution chain.
- ◆ Discussion among the groups, arguing why the photos are distributed this way, their order and variants.
- ◆ The teacher clarifies possible doubts and establishes the correct distribution of the photographs according to the distribution chain of citrus fruits.

STAGE 2

- ◆ Locate the various by-products generated in the corresponding steps.
- ◆ Add to each by-product the management and use alternatives, considering the colours:
 - By-product or economic problem = red**
 - Negative management or environmental problem = yellow**
 - Positive action or by-product recovery = green**
- ◆ Discussion among the groups, arguing the reasons for the locations of the by-products and their management.
- ◆ The teachers clarify any possible doubts.

Evaluation Resources

1 Attitudinal Assessment Rubric

Concept	Excellent (10)	Remarkable (8)	Sufficient (5)	Unsatisfactory (3)
Participation (35%)	It participates in all phases of the activity with great notoriety	It participates significantly in most phases of the activity	Participate correctly in general	Participation is very low or of poor quality
Role (50%)	He acts as a group leader, bearing much of the burden of managing the work	It influences and energizes different aspects of the activity	Although it does not contribute significant ideas, it participates without impeding the development of the activity	Stand as an impediment to the working group
Attitude (15%)	He works with great commitment and enthusiasm	Work actively	Work in moderation	Very poor working level

2 Concepts Evaluation by Kahoot

In order to evaluate the level of content assimilation of Module 1 by students, the following link can be used to access Kahoot.

[Kahoot Evaluation](#)

TOOLKITS

MODULE II. METHODS AND VALORIZATION TECHNOLOGY EXTRACTION OF ESSENTIAL OILS AND THEIR USE

Edited by: Anabela Cordeiro e Alexandra Pestana (Escola Profissional de Alte)

Introduction

The Main objective of the CitriVET project is the main objective of reusing dand citrus waste(pruning and fruit residues). One of the ways of reusing pruning is the transformation of these into animal feed *pelets* (using leaves) or biomass (using branches or wood change). Another way is the extraction of essential oils from leaves or peel of citrus fruits.

Essential oils or volatile oils are vital aromatic substances found in flowers, herbs, fruits and spices.

Essential oils are obtained from a plant or parts of the plant, by distillation or by process mechanicals appropriate without heating. Technically, this product is not oil, because it does not contain fatty acids, but high concentrations of plant components. This product is widely used in the pharmaceutical, therapeutic and cosmetic areas. It can help prevent and combat symptoms of some diseases, such as rheumatic and muscle pain.

Essential oils can, for example, help relax and sleep, improve digestion and even the appearance of the skin. Aromatherapy is the form of treatment included in the alternative medicine group recognized by the World Health Organization (WHO), which uses essential oils (of plant origin) to treat physical and emotional problems.

Objectives and skills

This activity has as main objectives:

- Use of citrus by-products
- Know the procedures for extracting essential oils from citrus by-products
- Use of essential oils
- Development of language skills
- Development of teamwork skills
- Critical thinking development
- Awareness of environmental awareness

RELATIONSHIP WITH CURRÍCULUM

This activity is related to commercial activities and consumer behavior

EXTRACTION OF ESSENTIAL OILS BY SOXHLET EXTRACTION

METHOD

LIST OF MATERIAL AND EQUIPMENT

- 100 gr of Orange peels 200 gr of Orange leaves,
- Ethanol,
- Balance,
- Soxhlet extractor,
- Heating blanket,
- Condenser of balls or serpentine,
- Round bottom balloon,
- Pipettes,
- Precipitation cups,

Procedure

Extraction with the Soxhlet extractor is performed when the desired compound has a limited solubility in a given solvent and impurities are insoluble in that same solvent. Allows for constant monitoring operation, as it works in order to use a small amount of solvent, which is constantly recycled, to dissolve a large amount of compound. The solvent used was ethanol, but may vary with the need to.

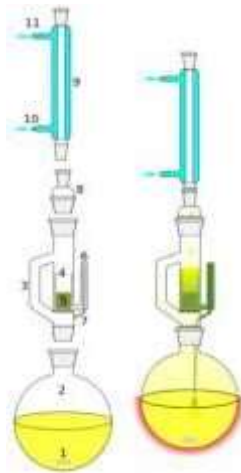


Figure 1 - Orange peels inserted in the



Figure 2 - Soxhlet

The Soxhlet extractor consists of three main sections: a percolator (a distillation balloon and a reflux condenser), which allows the reflux of the solvent, a thimble (a filter, usually consisting of thick filter paper), which retains the particles solid, and a siphon, which periodically empties the chamber where the thimble is placed.



- 1- Magnetic bar,
- 2- Distillation balloon,
- 3- Distillation arm,
- 4- Thimble
- 5- Raw material,
- 6- Siphon
- 7- Siphon output,
- 8- Expansion adapter,
- 9- Condenser
- 10- Cold water inlet,
- 11- Cold water outlet,

The solvent is then heated to start reflux. The solvent vapor passes through a distillation arm and fills the chamber where the thimble is located with the solid material. The condenser ensures that all steam cools, condenses and flows into the central chamber of the Soxhlet. The chamber slowly accumulates the solvent. Some of the compound to be extracted dissolves in the hot solvent. When almost all the space in the central chamber is filled with the solvent, it is emptied by the siphon. The solvent returns to the distillation flask, completing the extraction cycle. The thimble ensures that the rapid movement of the solvent does not drag solid particles into the flask. This cycle is repeated several times, for several hours, depending on the amount of compost needed and the ease with which it is extracted..

Link: https://i1.wp.com/upload.wikimedia.org/wikipedia/commons/d/d2/Soxhlet_mechanism.gif?resize=172%2C500

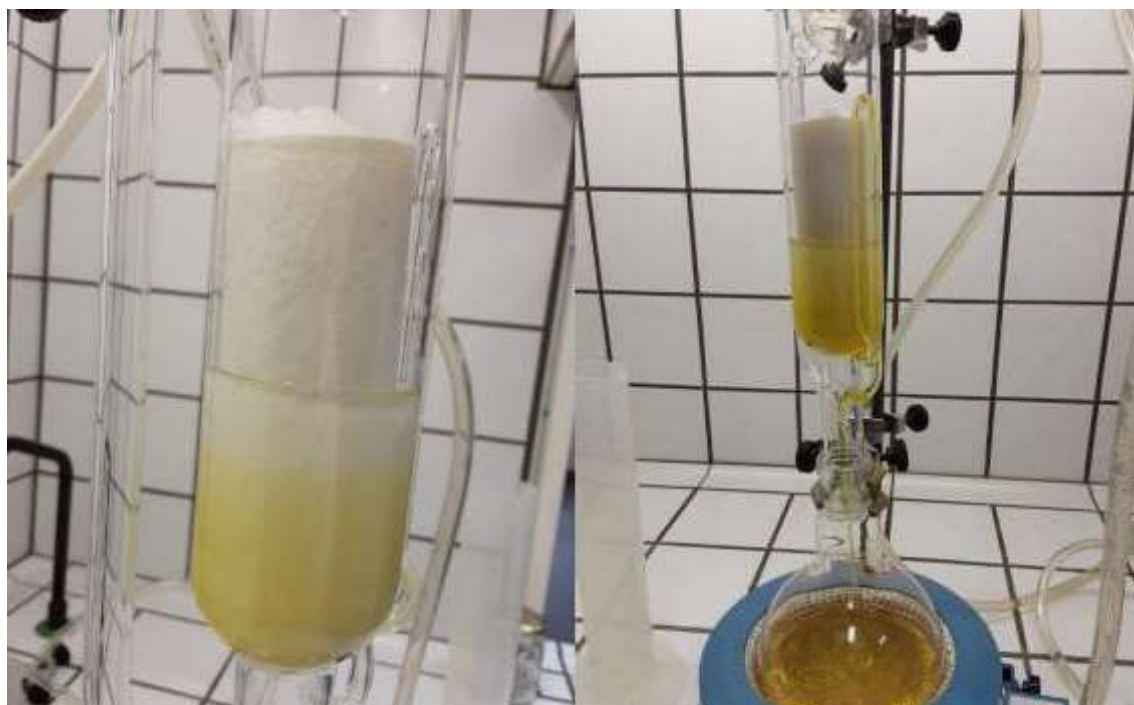


Figure 3 - Discharge capsule

Figure 4 - Boiling after the 1st discharge

Movie: Soxhlet Extraction

<https://photos.app.goo.gl/zGBQbGPaxjupx7Q17>

After extraction, the solvent is removed, usually using a rotary evaporator. The non-soluble portion of the solid remains in the thimble and is discarded.



Figure 5 - Evaporation of residual ethanol in extracted



Figure 6 - Essential oil extracted without



Figure 7 - Amount of essential oil extracted without purification

Subsequently, a purification of the extraction collected can be carried out with the help of a high-rotation centrifuge.

EXTRACTION OF ESSENCIAL OILS BY THE HYDRODISTILLATION METHOD

LIST OF MATERIAL AND EQUIPMENT

- 100 gr of Orange peels or 200 gr of Orange leaves,
- Distilled water,
- Balance,
- Distiller,
- Heating blanket,
- Condenser,
- Round bottom balloon,
- Pipettes,
- Precipitation cups,

Procedure



Figure 1 - Equipment



Figure 2 - Orange leaves in round back balloon

In this process, the raw material, orange leaves, is placed in a round-bottomed balloon mixed with distilled water. This balloon is heated in a heating blanket until boiling. Water vapor drags these volatile aromatic substances and reaches the condenser, passing through a cooling phase, where this mixture returns to liquid state.

However, essential oils do not mix with water, with a phase separation phase, in which the oily phase is at the top, and the aqueous phase at the bottom.



Essential oil extracted from the leaves in hydro distillation.

Movies: Hydro distillation. <https://photos.app.goo.gl/7fEEi4KgwePWxTi88>

EXTRACTION OF ESSENTIAL OILS BY THE MACERATION PROCESS WITH ALCOHOL

LIST OF MATERIAL AND EQUIPMENT

- For the extraction of essential oils by the cooking process with alcohol
- 100 gr of Orange or clement peels,
 - 200 ml food alcohol,
 - Glass bottle,
 - Glass funnel,
 - Paper filter,
 - Bath Mary,
 - Bottle with lid,

Procedure



Figure 1 - Orange peel prepared for maceration

- Place the orange/clement inlet peels, cut to pieces, inside a glass jar with lid;
- Add alcohol, with the help of a funnel, ace shells inside the glass jar;



Figure 2 -Shells in maceration with alcohol

- Place the bottle in a cool, dark place, or wrap the bottle on paper aluminum;
- Wait two weeks, gently shaking the bottle every day;
- At the end of the two weeks remove the solution and separate the shells from food alcohol filtering the solution.
- Place the liquid solution I obtained in a water bath for the alcohol to evaporate.

When the alcohol evaporates remove the remaining solution and put in a bottle with lid.

CANDLE PRODUCTION

LIST OF MATERIAL AND EQUIPMENT

For the production of candles

- 170 gr beeswax,
- Plasticine,
- Brush,
- Spatula,
- Vaseline,
- Microwave,
- Food Dye,
- Probe thermometer,
- Essential oil,
- Wicks,
- Glass container to melt wax
- Two sticks,
- Molds to make the candle,

Procedure

3. For the production of candles

- Place the mold to make the candles based on plasticine on a bit of cardboard, the plasticine will serve not to let the wax come out;



- Brush the interior with Vaseline;



- Place the beeswax in a glass container and place it in the microwave at a low power for 5 minutes, remove and mix with the help of a spatula until it is fully liquid. Repeat the process if necessary;

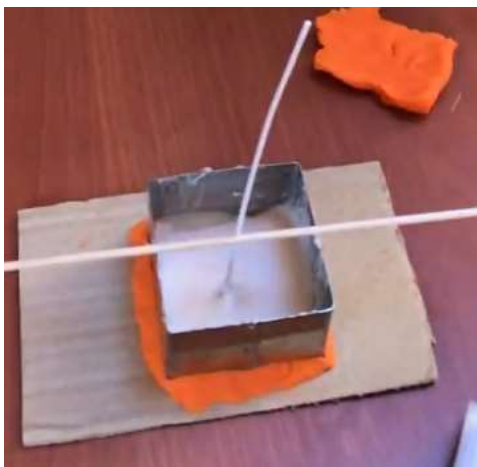


- Mix the food dye, with the help of spatula, to melted wax until the desired color is obtained. One can use a single color or several colors, depending on the creativity of each;

- Add essential oil to the wax when it is less than 40°C so that it does not evaporate. For every 100 gr of wax is added 10 drops of essential oil. Alternatively, you can dip the wick of the candle into the oil.

- Place some wax on the bottom of the mold and place the wick in the center of the candle mold.

Press to stick together. With the help of skewer chopsticks keep the right wick and add the wax up.



- Wait until the wax is dry, deform and cut the wick;

SOAP PRODUCTION

LIST OF MATERIAL AND EQUIPMENT

For the production of soaps

- 100g Glycerin,
- Microwave,
- Glass container to melt glycerin,
- Essential oil,
- 1 Orange and 1 lemon,
- Grater,
- Silicone molds,
- Probe thermometer,

Procedure

For the production of soaps

- Melt glycerin in microwave;
 - Cool the glycerin up to 40°C and add the essential oil. Orange and/or lemon zest can also be added;
 - Place glycerin in silicone molds;
- Wait until the glycerin becomes solid to deform.



Evaluation

The evaluation is made by KAHOOT.

EXTRACTION OF ESSENTIAL OILSEEDS BY SOXLET EXTRACTION -

<https://create.kahoot.it/share/extraccao-por-soxhelet/8ec6362d-a3e6-49a8-b367-6961b66578b7>

EXTRACTION OF OILS ESSENTIAL BY THE HYDRODISTILLATION METHOD –

<https://create.kahoot.it/share/hydrodistillation/aaec0841-53d9-4422-9212-b7b53b7279b5>

CANDLE PRODUCTION-

<https://create.kahoot.it/share/fabrico-de-velas-com-oleos-de-essencial-de-citricos/f9c55ffc-8dfe-4d0a-ad36-603c8006365f>

SOAP PRODUCTION

<https://create.kahoot.it/share/soap-manufacture/f0c625b2-752c-447d-bb7e-c278221a84c3>

TOOLKITS

Module III - BIOPRODUCTS MARKET

Edited by: Simone Marsala (ARCES)

Introduction

The EU bioeconomy makes up an important part of the total economy in the EU. According to the European Commission's 2016 report on the bioeconomy in Europe, it represents around 9% of all sectors of the economy with regards to employment (18,6 mln) as well as to turnover (EUR 2.2 trillion).

The report states that “the main hurdle for the production of bio-based products is to guarantee a stable supply of sufficient amounts of feedstock”.

At the moment only the bioenergy sector is regulated by EU legislation promoting the use of biomass, which in turn influences the availability and the price of biomass for other sectors.

At the same time, the plastics and chemicals industry is investing in several research projects focused on the use of alternative resources streams like municipal, forestry, agricultural wastes, recycled feedstock, algae or energy-related crops.

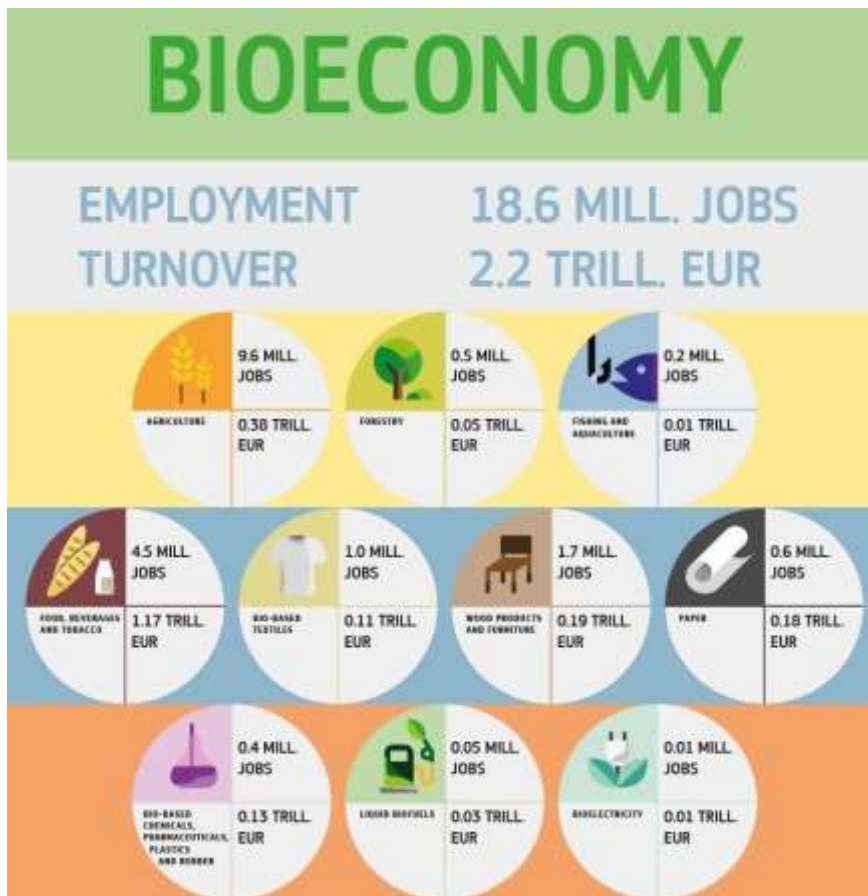
Policy:

A key policy tool for promoting the bioeconomy is represented by the European funding for research and innovation such as: the HORIZON 2020 framework Programme, the European Structural and Investment Funds (ESIF) and the European Fund for Strategic Investment (EFSI). Around 5.6% of the HORIZON 2020 budget is dedicated to the bioeconomy.

Overall, the report shows that “the bioeconomy concept, thanks to its versatility, can provide opportunities for many Member States and their regions, independently of their very different natural resources endowment”.

Definitely, cooperation between regions and EU Member States is needed for overcome market obstacles and thus guarantee access to renewable raw materials at competitive prices.

Some statistics about bioeconomy

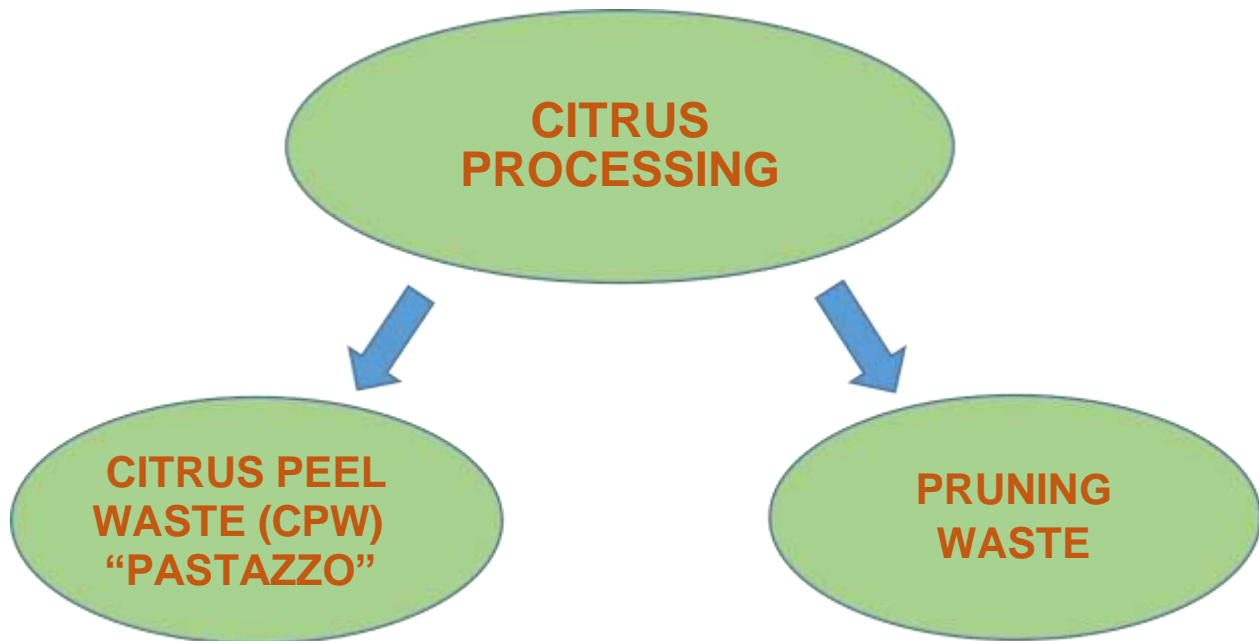


The economic impact of bioeconomy within the EU countries (2016)

THE CITRUS WASTE VALORISATION

Why citrus processing waste can represent a resource?

- **Citrus** (oranges, grapefruits, lemons, limes, and mandarins) are one of the most widely cultivated groups of fruits across the globe.
- **Citrus production** is increasing every year due to increasing consumer demand.
- **Citrus processing industries** generate huge amounts of wastes every year and citrus peel waste alone accounts for almost 50% of the wet fruit mass.
- **Citrus wastes** are of immense economic value as it contains abundant amounts of various flavonoids, carotenoids, dietary fiber, sugars, polyphenols, essential oils, ascorbic acid and considerable amounts of some trace elements.
- **Citrus wastes** also contain high levels of sugars suitable for fermentation for bioethanol production. However, compounds, such as d-limonene must be removed for efficient bioethanol production.



1) Citrus Peel Waste (CPW) - *Pastazzo*

“Pastazzo”, as Citrus Waste (CW), is the main by-product of the citrus processing industries, and it is composed by peels, seeds and squeezed pulp. CPW, as the main residue of the citrus processing industries is characterised by a seasonal production (which often requires biomass storage) as well as high water content and concentration of essential oils. The disposal of CPW has considerable constraints due to both economic and environmental factors. Currently this residue is mainly used as food for animals, thanks to its nutritional capacity. If enough agricultural land is available close to the processing industries, the use of CPW as organic soil conditioner or as substrate for compost production is also possible, thus improving the organic matter content of the soil. Considering the high added value of the compounds that can be recovered from CPW, it has promising potential uses: in the food industry (for production of pectin, dietary fibers, etc.), and in the cosmetic and pharmaceutical industries (extraction of flavonoids, flavouring agents and citric acid). However, in many cases, these uses are still not economically sustainable.

➤ *Uses of CWP by-product:*

- Livestock supplement
- Fertilizers for cultivation
- Production of biogas and bioethanol
- Production of fibers and other products for human consumption

- Recently, the possibility of its valorisation for bio methane or bioethanol production has been evaluated by several studies, but currently more research is needed to overcome the toxic effects of the essential oils on the microbial community. Despite the various hypothetical uses, however, often the management of the citrus pulp is very expensive, in fact, CPW characteristics make its management economically and environmentally complex.

- **Bio-based products**

The term **bio-based product** refers to products wholly or partly derived from materials of biological origin (excluding materials embedded in geological formations and/or fossilized).

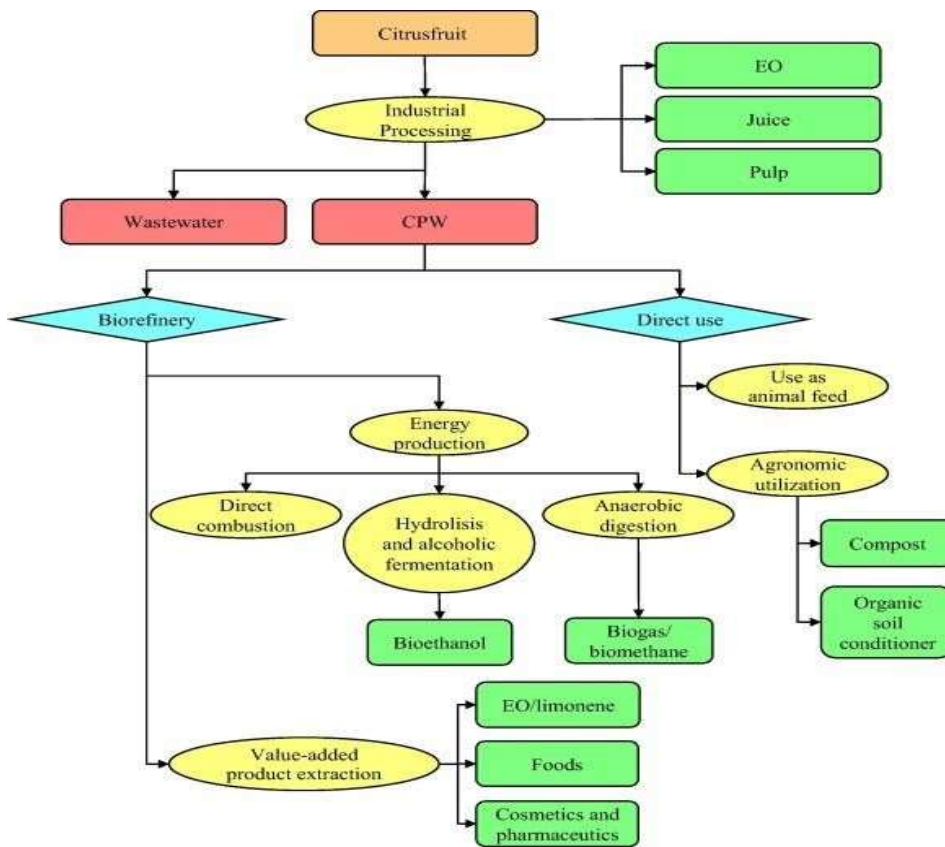
In **industrial processes**, enzymes are used in the production of chemical building blocks, detergents, pulp and paper, textiles, etc.

- **Bio-based products coming from valorisation of citrus processing waste (CWP)**



- Essential oil
- Textiles
- Food supplements
- Flour
- Pectin
- Bioplastic (a type of biodegradable plastic derived from biological substances rather than petroleum)

Citrus waste valorisation cycle



2) Pruning waste

As global waste production, rates are expected to continue rising during the following decennium, the development and selection of sustainable waste management solutions becomes more and more pressing during last years. Nowadays, despite an increasing need to valorize the processing waste in agriculture, mostly of pruning waste of citrus trees are still incinerated with a negative impact on the air and to the environment due to toxic particles. Definitely, many agricultural entrepreneurs still consider pruning waste, as residues without any economic and commercial value.

At the same time, the number of enterprises and farmer trying to convert citrus pruning residues from cost into products with an added value is constantly increasing. Citrus pruning waste is composed by a mixture of wood and leaves and, such as the CPW, the pruning residues can be used for the production of bio-based products:

- Pellet
- Ruminant livestock supplement



1) Pellet



2) Pruning waste



3) Livestock supplement

FROM AGRICULTURE TO RURAL BUSINESS START UP

Agriculture 4.0

Agriculture is evolving day-by-day from traditional forms to increasingly evolved forms. In particular, modern forms of agriculture adopt new technologies, apply innovative processes and are oriented towards the creation of new products.

In this context, the so-called "Agriculture 4.0" is the evolution of the concept of "precision agriculture" which is used to define targeted and efficient interventions in the agricultural field starting from data. Such whole set of tools and strategies allow the farm to use advanced technologies in a synergic and interconnected way with the aim of making production more efficient and sustainable. Adopting 4.0 solutions in the agricultural field includes, for instance, a groundbreaking approach to water management resources in order to prevent water waste, or to avoid plant diseases by identifying plant pests in advance.

One of the most interesting perspectives related to the agriculture 4.0 is the traceability of the supply chain using new technologies. Thanks to the **Blockchain technology**, during each step, from the field to the packaging, it is possible to collect useful data to keep every step of the production process under control.

A new business model approach

A further business model applied to agriculture takes into account the "market" evolution of the economy. It is no longer based on the company's ability to produce a specific agricultural product, but to follow market trends in directing its production process.

This entails a corporate reorganization also in the sense of promoting better integration within the supply chain. Both horizontal (producer associations) and vertical (supply chain consortia, food and agriculture districts, etc.) forms are increasingly widespread. This evolution requires farmers to be more and more informed and competent, not only in their production areas, but also on transversal themes that indirectly influence their activity.

Such approach can help farmers to improve several aspects of their business activities, mostly for those related with:

- strategic management of business operations;
- better b2b coordination between farmer groups and buyers;
- ability to understand customer and value chain needs and priorities.

INNOVATIVE START UP IDEAS

1) Orange Fiber

Orange Fiber is a company seated in Sicily, which made up of equal parts innovation and elegance. It "creates exquisite sustainable textiles from citrus juice by-products that would otherwise be thrown away, representing hundreds of thousands of tons of precious resources. The company tries to envision a new life for these materials, transforming them into refined, ethereal fabrics perfectly suited to Italy's artisanal tradition of high quality textiles and high fashion".



<http://orangefiber.it/>

2) Experimental Juice Bar



Would you like an orange juice squeezed into a 3D printed cup? This is the project imagined by the architect Carlo Ratti who developed a rather special juice bar, this one allows for orange peels to be transformed into 3D printed cups.

<https://www.3dnatives.com/en/orange-peels-3d-printed-cups-180920195/>

3) Agroptima, an agritech startup

Founded in 2014, this Barcelona-based startup allows farmers to manage their farms from their phones. Using its app, farmers can track jobs, fields, products, workers, and machinery. The app records daily farm operations such as sowing, fertilising, and harvesting, and farmers can access all of the data on its web-based platform.



<https://www.agroptima.com/en/>

EVALUATION

The evaluation is made by KAHOOT.

➤ **Bioproducts market**

<https://create.kahoot.it/share/module-3-bioproduct-market/72b616af-c1ed-4f17-9873-7caa9be27f33>

➤ **From agriculture to rural business start up**

<https://create.kahoot.it/share/enter-kahoot-title/d2416ba7-50bc-4ef1-8235-412e2972a8ed>

*Remember that before sharing the test with the students you need to create a 'challenge'.

VIDEO

<https://youtu.be/9DqOS5-uBcM>

REFERENCES

Duarte, A., Segarra J., Jorro J., Merloni E., Campana G., Pernice A., Rodríguez A., Marsala S., *The transformation of citrus waste in bioproducts. Techniques, methodologies and technologies. Manual for agricultural VET teachers*; CitriVET Project Consortium, 2019.

Tirone A., *Condizionamento e utilizzazione di scarti e sottoprodotti dell'industria agrumaria nella Coltivazione di "cichorium endivia"*, Palermo, 2015.

D.A. Zema, P.S. Calabrò, A. Folinoa, V. Tamburino, G. Zappia, S.M. Zimbonea, *Valorisation of citrus processing waste: a review*, Waste Management, Elsevier Ltd., 2018.

<https://www.cen.eu/work/areas/chemical/biobased/pages/default.aspx>

<https://www.european-bioplastics.org/european-commission-2016-report-on-the-bioeconomy/>

<https://lifelowcarbonfeed.com/en/results/>

https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_p_r_o_j_id=6236&docType=pdf

<https://www.ambienteambienti.com/recupero-di-rifiuti-agricoli-pratiche-innovative-con-life-lowcarbon-feed/>

<https://www.3dnatives.com/en/orange-peels-3d-printed-cups-180920195/>