CO FRESH

Using biotechnology to turn leftover clementine juice parts into useful food ingredients

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000852

Brussels, 31st March 2023

co-fresh.eu

Le Terre di Zoe'

Farm located in the South of Italy - in the districts of Reggio Calabria and Vibo Valentia

- Overall extension of 15 hectares
- Olives and fruit cultivation
  - Valencia Late Oranges
  - Blood Oranges
  - Clementine
  - Lemons
  - Pomegranate
  - Avocado
  - Kiwi Hayward

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Le Terre di Zoe'

The products:

- Fresh fruits
- Juices and nectars
- Jams
- Marmalades
- Compote
- Olive oil
- Spices
- Essential oils

- ✓ Organic fruits & raw materials
- ✓ No preservatives
- ✓ No added sugars

Le Terre di Zoe'

Pilot case: Organic fresh and processed fruits

- ✓ 7 ha of land for clementine cultivation
- ✓ 30 Tons of fruit yearly produced
- ✓ 3 Tons used to produce the juice

Juice: 30-35%

Residue: Peel, pulp, seeds (60-65% of processed fruit)

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Valorisation of citrus processing wastes

Animal feed

Citrus residues

Added-value product recovery

Agronomic use

Energy production

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Citrus residue composition

Composition (weight)

- Water: 85%
- Total dietary fiber: 6 %
- Carbohydrates: 2-4 %
- Proteins: 1 %
- Minerals: 0,5-0,6 %
- Fats: 0,1 %

pH 3,5-4,5

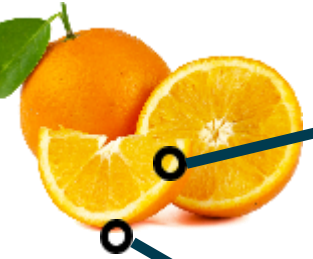
- Ascorbic acid
- Citric acid
- Malic acid

Sugars

- Mono- & disaccharides (30-36%)
  - Glucose
  - Fructose
  - Sucrose
- Polysaccharides
  - Cellulose ~20%
  - Hemicellulose~15%
  - Pectin ~22%
  - Lignin ~6%

This project has received research and innovation

Added-value components



Albedo → Pectin

Flavedo → EOs → Hydrocarbons
Aldehydes

Hydrocarbons → Sesquiterpenes
Hydrocarbons → Monoterpenes (70-95%) → D-limonene

- Valuable compounds, e.g. antioxidant, antimicrobial, fibers, food additives (gelling, thickeners),..
- Source of value-added-bio-based chemicals
- Substrate for biotransformation

Extraction of added-value components

- Essential oils - D-limonene
- Pectin – thickener, emulsifier and stabiliser
- Dietary fibers

- Phenolics - antioxidant, anticarcinogenic, antiinflammatory, antioxidant, anti-aging, cardio-protective

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Valorisation of citrus residue as food ingredient

Citrus residue

Stabilization

Formulation

High Pressure Homogenization

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Valorisation of citrus residue as food ingredient

Before HPH treatment

FLUID

After HPH treatment

VISCOUS

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Valorisation of citrus residue as food ingredient

By modulating the HPH treatments and formulation, citrus-based products with the desired shelf-life, chemico-physical, microstructural and functional properties can be produced

Fillers for bakery products

Creamy desserts

Beverages

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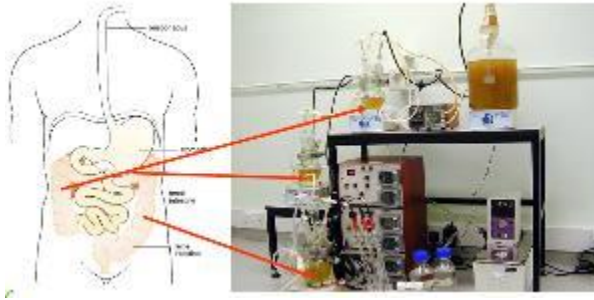
Valorisation of citrus residue as functional food ingredient

- ✓ High fiber content
- ✓ Limited content of digestible compounds
- ✓ High water absorption ability



Possible prebiotic activity towards fecal microbiota?

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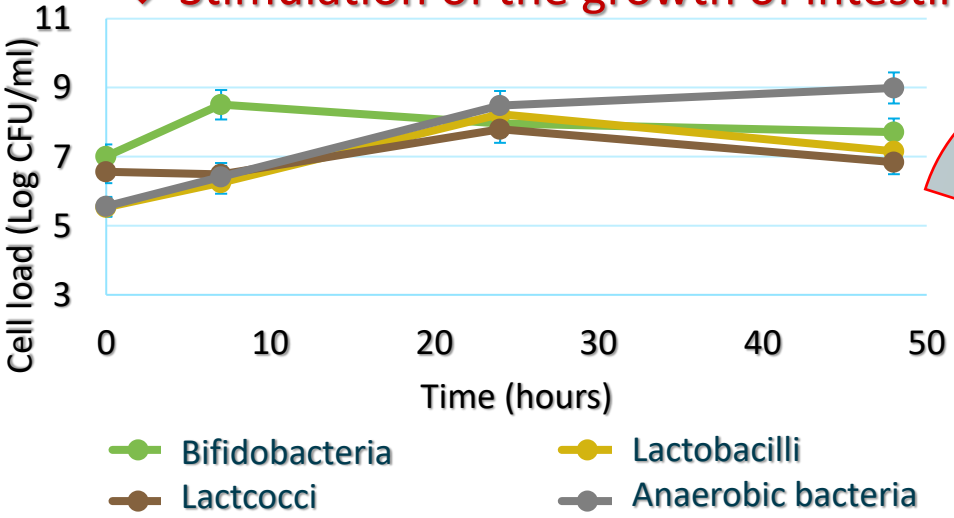
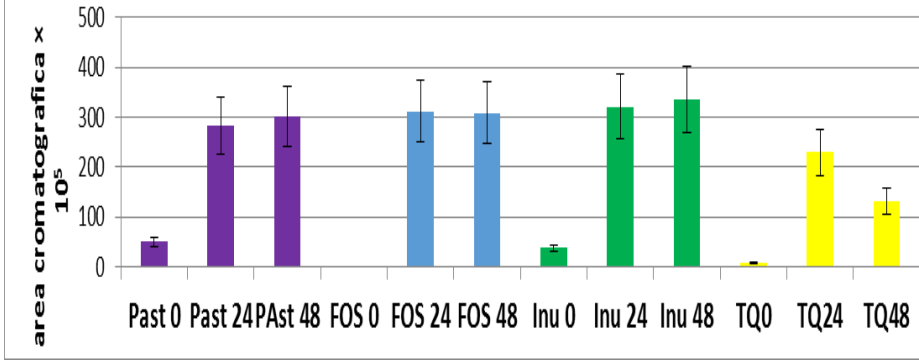
In vitro study of the citrus residues bioacivity

❖ Stimulation of the growth of intestinal microbiota



❖ Production of microbial metabolites (short chain fatty acids) which are reported to have posittive effect on humans

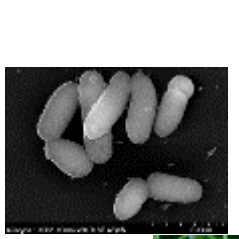
Propanoic acid – citrus vs prebiotics

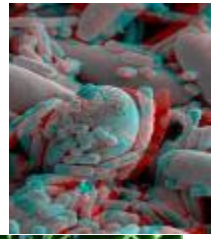


Le Terre di Zoe' – Clementine leftover from juice production

Valorisation of clementine residue by microbial fermentation

- ✓ Sustainable biotechnology
- ✓ Mild/environmental processing conditions
- ✓ No (limited) need for chemicals





1. Set-up of a biotechnological process assisted by mild technology, based on selected GRAS yeasts and lactic acid bacteria
2. Production of a functional ingredient

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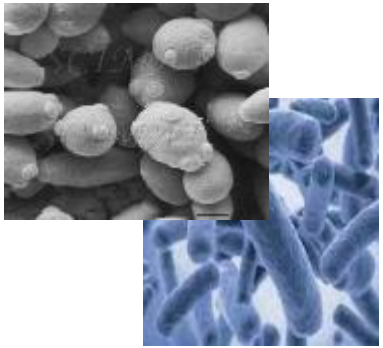
Valorisation of citrus residue by microbial fermentation

Orange residue

Grinding

Mild processing

Yeasts & LAB



Inoculum & fermentation

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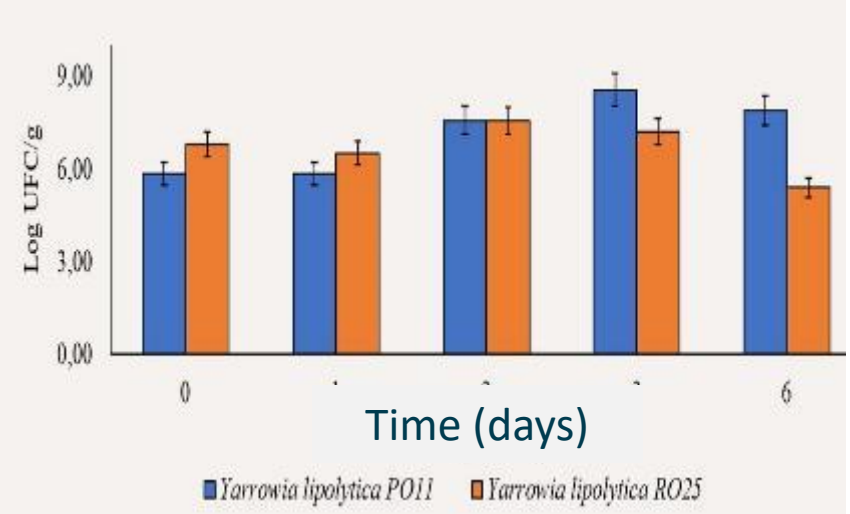
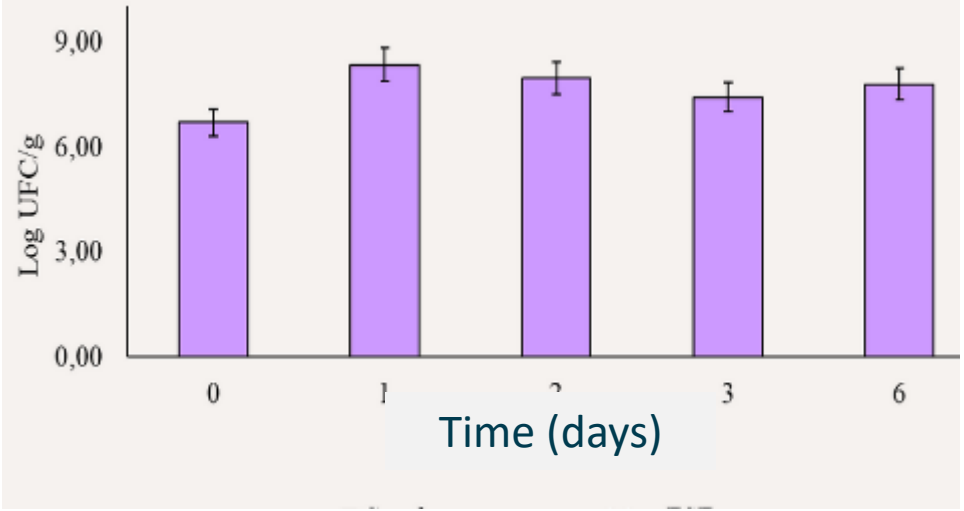
Valorisation of citrus residue by microbial fermentation

❖ Viability of the yeasts during fermentaion

Yarrowia lipolytica



Saccharomyces cerevisiae



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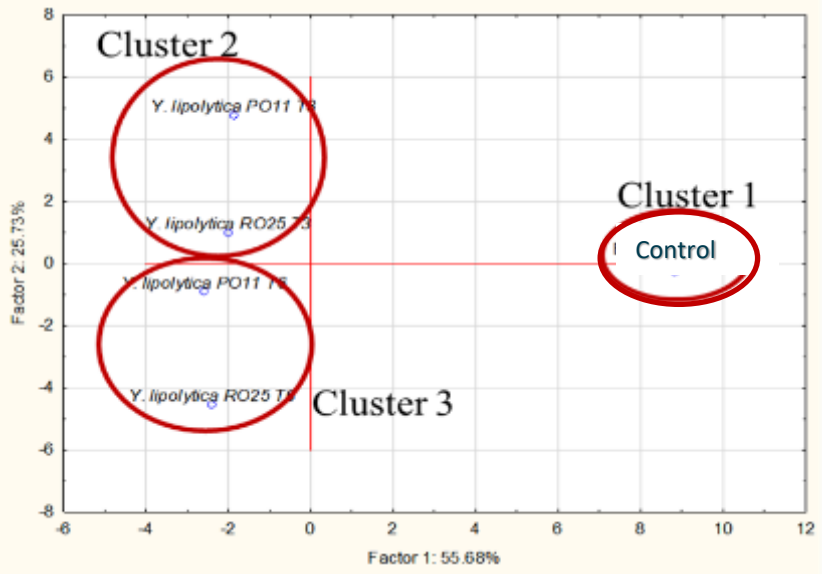
Valorisation of citrus residue by microbial fermentation

❖ Volatile aroma compounds



Reduction of terpenes and increase of the corresponding terpenic alcohols and aldehydes

Positive impact on the aroma

↓ Hexanal	↑ 1-Hexanol
↓ Octanal	↑ 1-Octanol
↓ Nonanal	↑ 1-Nonanol
↓ Ethanol	↑ Ethylic esters
↓ Terpinene	↑ α- Terpineol

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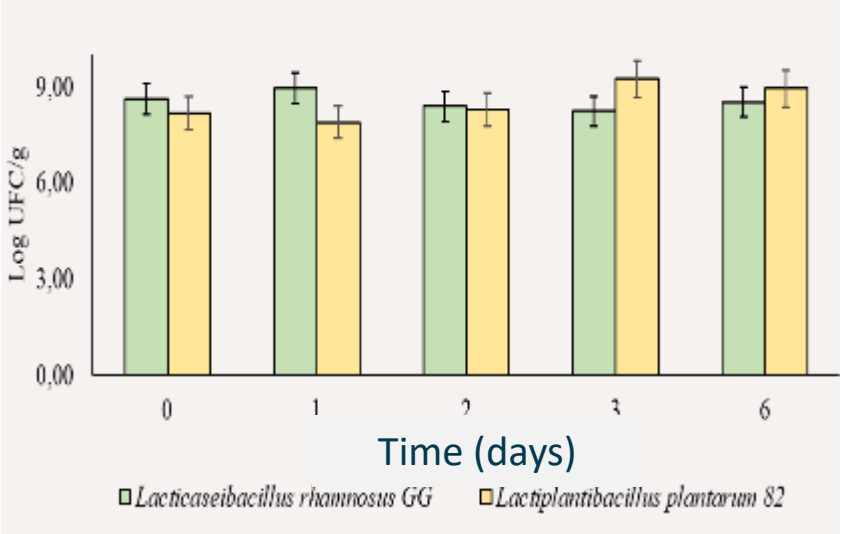
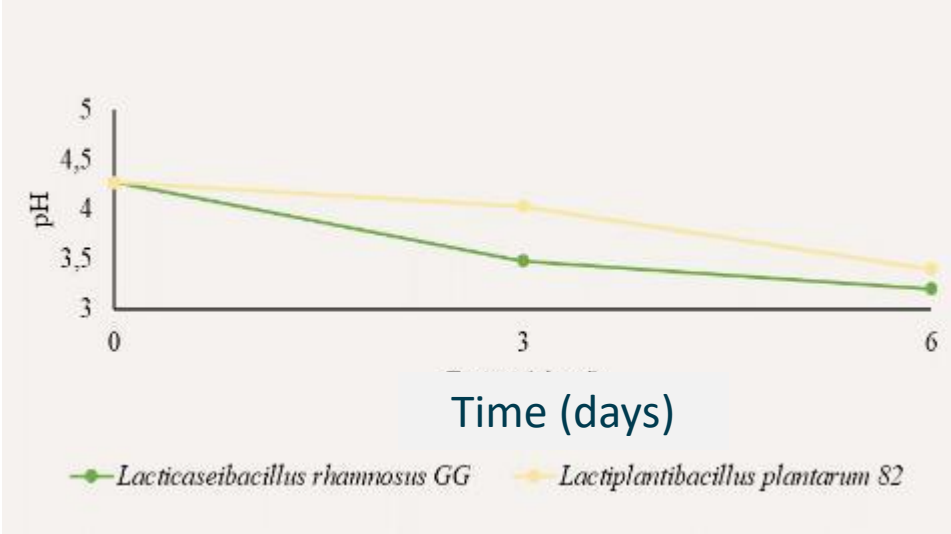
Valorisation of citrus residue by microbial fermentation

❖ Viability of the lactic acid bacteria during fermentaion





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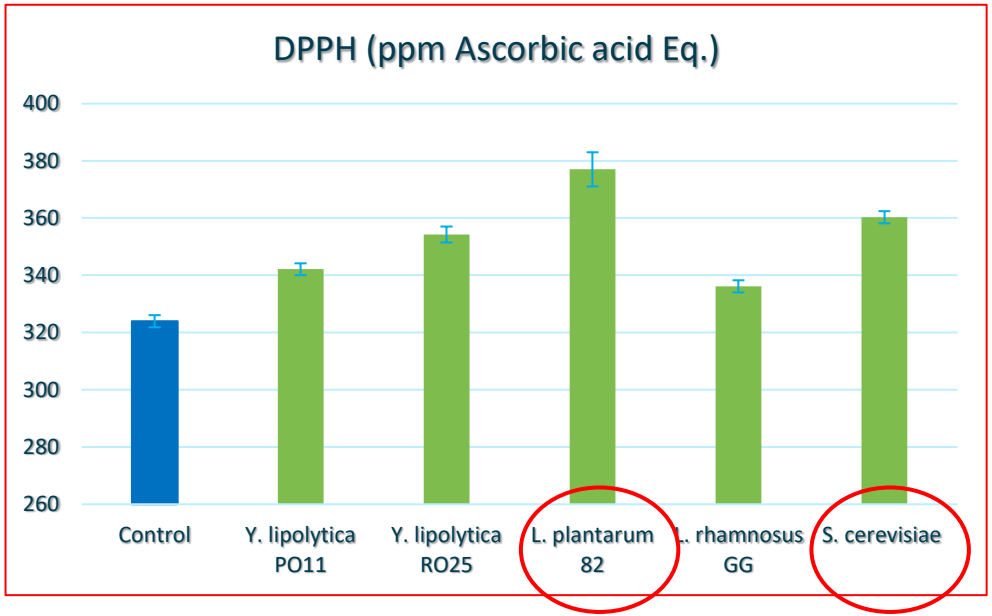
Valorisation of citrus residue by microbial fermentation

❖ Antioxidant activity of the fermened orange residue



Improved antioxidant activity depending on the fermenting microorganism and strain

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Le Terre di Zoe' – Clementine leftover from juice production

Valorisation of clementine residue by microbial fermentation

1. Set-up of a biotechnological process based on selected GRAS yeasts and lactic acid bacteria and assisted by mild technology
2. Characterisation of the functional ingredient
3. Use of the innovative functional ingredient for the formulation of new innovative product(s) or modification/enrichment of already produced by le Terre di Zoè

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Thank you for your attention!

CNTA

le Terre di Zoe organic farm

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

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