

FRUHPH: Application of ultra high-pressure homogenisation in fruit juices and wines to improve quality and additive-free preservation

Summary

Ultra high-pressure homogenisation (UHPH) is an emerging physical technology with potential applications in the food industry. UHPH is a non-thermal, fast and efficient technique for sterilising liquids at low temperatures, thanks to its high capacity for inactivating microorganisms by cell disruption and inactivating oxidative enzymes that can damage the quality of the product. UHPH treatment improves the shelf life and physical-chemical and sensory stability of liquid foodstuffs, in line with a growing market trend.

This project aims to explore applications of UHPH technology in two food areas: (1) fruit juices, to obtain juices and concentrates that have undergone less processing, avoiding sterilising filtration and aggressive heat treatments; and (2) wines, applying this emerging technology at different stages of the wine-making process: in the must prior to fermentation in still and sparkling wine; for ageing in red wine; in sweet wines or on lees, reducing the need for adding sulphites and reducing or eliminating indigenous or contaminating microbial population. In general, the aim is to obtain juices, musts and wines with fewer additives (sulphites) and less processing but with an optimal, improved sensory and nutritional quality.

Objectives

The main objective of the project is to test UHPH as a non-thermal physical technology for stabilising plant-based beverages such as wine, juices and concentrates in order to reduce the use of preservatives and improve their organoleptic properties.

Current UHPH systems have not yet been tested at all the possible stages where it could be applied to ensure the wine and juice industries meet a variety of requirements. Hence testing in real environments is necessary.

The specific objectives of the project overall are:

1. Validate UHPH technology in the plant-based beverage industry (juices, concentrates and wines) and study the shelf-life of pasteurised and sterile products storable at refrigerated and ambient temperatures, respectively.
2. Assess and quantify improvements in the nutritional and functional characteristics of the beverages obtained.
3. Assess improvements in the sensory profile of the products with respect to current preservation techniques.
4. Eliminate or reduce the use of chemical preservatives in the production of plant-based beverages, in particular juices, concentrates and wines.
5. Create new products, such as young wines available all year round, and increase the market for them.
6. Improve the energy efficiency of the plant beverage industry.
7. Raise awareness among standardisation and regulatory agencies and wine consumers of the benefits of UHPH as an alternative method to obtain products with fewer preservatives.
8. Generate synergies among the stakeholders in the plant-based beverages sector through a collaborative project in which the results will be shared, improving the competitiveness of all the companies and creating a sector-wide impact for the project.

Description of the actions planned in the project

A series of actions will be carried out involving a large number of processes, generating new products on the market:

In the **wine sector**:

1. In the *must*, reduce or eliminate the microbial load, thus allowing storage of the UHPH-treated must for longer after it has been produced, for different purposes: as a source of sugar for secondary fermentation, as yeast culture growth medium and for wine-making outside the seasonal period (August-September), without the risk of advanced spontaneous fermentation while avoiding the use of high concentrations of sulphites for preservation.
2. In *still wine*, prior to bottling, use UHPH for microbiological stabilisation, avoiding adding sulphur or antimicrobial filtration.
3. In *base wine intended for sparkling wine production* to avoid a problem currently encountered by some producers, namely malolactic fermentation in the bottle, which harms the sensory quality of the wine. The effectiveness of UHPH treatment in eliminating lactic acid bacteria will be studied.
4. In *red wine intended for barrel-ageing* which is susceptible to contamination by *Brettanomyces*, a yeast whose metabolism can produce volatile phenols that may impair the sensory quality of the final wine. UHPH technology may be able to eliminate or inactivate this contaminating yeast.
5. In *sweet wines*, to stabilise them microbiologically before bottling, avoiding the use of high doses of sulphur dioxide to prevent refermentation in the bottle.
6. Treatment of *lees* and *mother yeast*. Lees ageing is a process used in some types of wines, especially whites. During this operation, the yeast cells are broken down (autolysis) and the wine is enriched with substances found in the cell walls, mainly mannoproteins, which generally improve the sensory profile of the wine. Autolysis is a relatively slow process. Applying UHPH to the lees could speed up autolysis or yeast breakage, which can shorten the ageing period.

In the **juice and juice concentrate sector**:

1. In *clarified and non-clarified apple and orange juices preserved at refrigeration and ambient temperatures*, to stabilise them in physical-chemical and microbiological terms using various UHPH treatments, preventing their deterioration due to enzymes and microbiological causes, minimising the loss of their nutritional and sensory qualities, due to the low thermal effect of this technology. In the case of juices preserved at room temperature, the most resistant sporulated microorganism, *Alycyclobacillus* spp., which develops in acidic conditions, has to be eliminated, so UHPH treatment will be at a higher pressure and with a higher product input temperature, while maintaining its quality.
2. *Apple and peach juice concentrates kept at room temperature*. The chemical characteristics of these products, which have a higher concentration of sugars, condition their organoleptic and nutritional quality, since the traditional application of heat treatments, especially for eliminating *Alycyclobacillus*, notoriously affects the production of non-enzymatic browning components, affecting sensory quality and safety, due to increased production of furans. Therefore, as in the previous case, application of the lower temperatures and, above all, shorter contact times involved with UHPH treatments should make it possible to obtain better-quality concentrated juices than with conventional thermal treatments.

Expected results and practical recommendations

The main result of the project is the validation of UHPH technology in the plant-based beverages sector (juices, juice concentrates and wine).

Specifically, the expected results for the **wine sector** are:

- Microbiologically stable musts with a longer shelf-life, for use in wineries for different purposes beyond the seasonal harvest period.
- Musts free of indigenous microorganisms where biotechnological fermentation processes using different types of starter cultures (non-*Saccharomyces* yeasts, selected strains of *Saccharomyces*, co-inoculation of lactic bacteria + *Saccharomyces*) are much more effective because there is no competition with the natural microbiota of the must.
- More stable bottled wines (still or sweet).
- Base wines for sparkling wine production that maintain a higher quality in terms of acidity and pH by eliminating the presence of lactic bacteria and avoiding malolactic fermentation (MLF).
- Aged wines (white or red) with a lower or no chance of *Brettanomyces* contamination.
- White wines with a faster lees ageing process, which can shorten production times.

In general, musts and wines with fewer additives, especially sulphites, and less processing (avoiding sterilising filtration) but with an optimal and/or improved sensory quality.

Regarding the application of UHPH in **fruit juices and fruit juice concentrate**, the expected results are:

- Establishing the optimal UHPH treatment parameters to obtain clarified, non-clarified, safe and physically, chemically and microbiologically stable *fruit juices* during *refrigerated storage*, equivalent in these aspects to thermally pasteurised juices, but with significantly improved organoleptic and nutritional characteristics.
- Establishing the optimal UHPH treatment parameters to obtain clarified, non-clarified, physically, chemically and microbiologically stable *fruit juices* (especially as regards resistant spoilage microorganisms such as *Alicyclobacillus* spp.) during *storage at room temperature*, equivalent in these aspects to thermally sterilised juices, but with significantly improved organoleptic and nutritional characteristics.
- Establishing the optimal UHPH treatment parameters to obtain *fruit juice concentrates* that are physically, chemically and microbiologically stable (in particular as regards resistant spoilage microorganisms such as *Alicyclobacillus* spp.) during storage at room temperature, equivalent in these respects to thermally sterilised concentrates, but with significantly improved characteristics.

Leader of the Operational Group

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Coordinator of the Operational Group

ORGANISATION: INNOVI Association of Innovative Companies

Other members of the Operational Group (grant recipients)

ORGANISATION: JUVÉ Y CAMPS, SA

ORGANISATION: UNIÓ ORIGEN, SCCL

ORGANISATION: SAT N 1596 NUFRI RESP LIMIT

Other members of the Operational Group (not recipients of the grant)

ORGANISATION: IRTA - Institute of Agrifood Research and Technology

ORGANISATION: CENTRE FOR INNOVATION, RESEARCH AND TRANSFER IN FOOD TECHNOLOGY - AUTONOMOUS UNIVERSITY OF BARCELONA

Subject area(s) of application

- Agricultural production system
- Agricultural practice
- Agricultural equipment and machinery
- Livestock farming and animal welfare
- Vegetable production and horticulture
- Landscape / Territorial management
- Pest and disease control
- Fertilisation and nutrient management
- Soil management
- Genetic resources
- Forestry
- Water management
- Climate and Climate Change
- Energy management
- Waste and by-product management
- Biodiversity and environmental management
- Food quality/processing and nutrition
- Supply chain, marketing and consumption
- Competitiveness and agricultural and forestry diversification
- General

Geographical area(s) of application

PROVINCE(S)	REGION(S)
Lleida, Barcelona, Tarragona	Pla d'Urgell, Alt Penedès, Baix Camp

Dissemination of the project (publications, conferences, multimedia, etc.)

News related to the progress of the project will be posted on the INNOVI.cat website and disseminated on the social media of INNOVI and the cluster partners.

Project website

<https://www.innovi.cat/fruhph>

More information on the project

PROJECT DATES	TOTAL BUDGET
Starting date: July 2021	Total budget: €203,520.00
	DACC funding: €94,118.40
Current status: Under way	EU funding: €71,001.60
	Own funding: €38,400.00

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Order ARP/113/2021 of 20 May, approving the regulatory bases for grants for cooperation for innovation by promoting the creation of European Association for Innovation operational groups in the areas of agricultural productivity and sustainability and the execution of innovative pilot projects by those groups, and Resolution ACC/1660/2021, of 27 May, announcing the call for the grant.



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