Project Name: MIDIFRUIT - Microfluidic platform for detecting fruit infections from production to post-harvest processing at the point of impact
Contract Number: 2023.16677.ICDT
Funding Program: FCT - Fundação para a Ciência e Tecnologia/FEDER
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Coordinating institution: INESC MN
Partner Institution: FCiências.ID

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Abstract

MIDIFRUIT develops a portable microfluidic device for rapid on-site pathogen detection during fruit production and post-harvest processing. It addresses speed, affordability, simplicity, and high performance in detecting Botrytis cinerea. Current methods are costly and time-consuming. The project involves assay development, portable system creation, optimization, calibration, lab, and field tests.

Overview of the MIDIFRUIT detection process from field sampling to on-site nucleic acid detection and of the concept of the portable MIDIFRUIT platform combining a disposable microfluidic biochip with a portable reader for in-field pathogen detection.

Total Project Budget: 248.832,00 EUR | **Funding Allocated to INESC MN** 198.720,00 EUR

MIDIFRUIT Device Workflow

Step-by-step process for rapid pathogen detection in the field.

Sample → DNA Extraction → Amplification → Detection → Result

MIDIFRUIT System Concept

Portable microfluidic device for in-field detection of pathogens in fruits.

Portable Reader + Microfluidic Biochip

- **Quick** & Early Detection
  On-site via Microfluidic Biochip
- **Portable & Cost-effective**
  Easy to Use in Agri Fields
- **Reduces Pesticide Use**
  Sustainable Crop Management

MIDIFRUIT System Concept

Portable microfluidic device for in-field detection of pathogens in

- Quick & Early Detection
- On-site via Microfluidic Biochip
- Portable & Cost-effective

MIDIFRUIT Project Objectives

Develop an innovative **point-of-use microfluidic device** for **rapid detection** of **fruit** infections in the field.

Detect *Botrytis cinerea*

Identify *Botrytis cinerea* infections early in fruit before symptoms appear.

Versatile Platform

Adaptable for **Grapevines & Other Crops** from Farm to Consumer

Reduce Pesticide Use

Minimize **pesticide** use & environmental impact

High Sensitivity Testing

Achieve rapid, sensitive detection down to **10 CFU/mL**

Key Requirements

FAST
Results in **2-6 Hours**

INEXPENSIVE
Cost 1-3 Euro per Test

SIMPLE
Easy to Use in the Field

HIGH PERFORMANCE

Main Components

Assay Development

Portable System

Optimization & Calibration

Extension to Other Fruits

Objectives:

MIDIFRUIT aims to develop an innovative point-of-use miniaturized analytical device for rapid, in-field control of pathogen infections in fruits. This device relies on a portable, easy-to-use microfluidic biochip for high-sensitivity nucleic acid detection. The MIDIFRUIT platform is versatile and adaptable, allowing for a

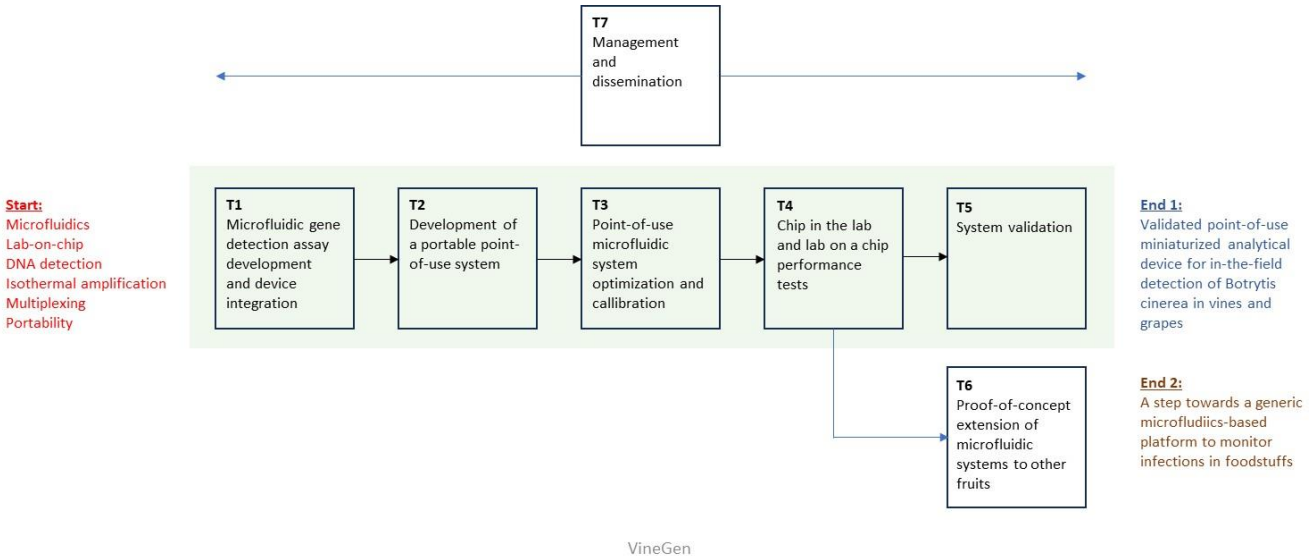
wider range of potential end uses. These include monitoring infections in grapevine (Vitis vinifera) and other agricultural crops at all stages of food processing from the plant to the consumer and extending the platform to detect other nucleic acid biomarkers.

Microorganism infections pose a significant threat to crop production and post-harvest processing, often resulting in widespread destruction. Current sampling and testing methods are costly, labor-intensive, and prone to delays, allowing infections to spread unchecked. Existing monitoring techniques are either time-consuming or expensive, requiring specialized staff and laboratory facilities. Consequently, excessive pesticide use is common, leading to environmental impact and food losses. The primary aim of this project is to develop a microfluidic-based point-of-use device capable of detecting fruit infections at an early stage. This will enable efficient and sustainable management of the food production cycle, reducing reliance on pesticides and minimizing environmental impact.

The primary focus of this project is on detecting the presence of Botrytis cinerea through genomic sequences. The main objective is to develop a portable microfluidic device capable of quantitatively detecting these microorganisms in the field before visible symptoms appear on the fruit. The project aims to achieve sensitivity levels that correlate with gold-standard laboratory measurements. Drawing on previous work with microfluidic detection of stress hormones in grapes and vines, as well as recent advancements in isothermal nucleic acid amplification processes, the project aims to miniaturize these processes into a portable microfluidic system.

However, the uptake of the platform by the producers will require that it be: (1) FAST – it must be fast enough to allow decisions to be taken based on limited sampling in the field (max. 2-6h per analysis); (2) INEXPENSIVE – for routine analysis, a maximum cost of 1-3 Euro per analysis is envisaged; (3) SIMPLE – minimal user intervention and minimal steps for sample preparation and analysis (to be operated by minimally trained staff in the field); (4) WITH HIGH PERFORMANCE – fit-for-purpose sensitivity (expected at down to 10 CFU per mL), and fit for purpose selectivity and repeatability. Meeting these requirements presents significant scientific and technical challenges which have not yet been satisfactorily addressed.

The project consists of eight main components: Assay Development and Integration, Portable System Development, System Optimization and Calibration, Tests and Validation, Extension to Other Fruits, Management, and Dissemination. These components encompass various stages of the project, including developing microfluidic modules for detecting microorganisms in grapes, miniaturizing the assay into a portable system, optimizing, and calibrating the system, validating it with field samples, extending the technology to monitor infections in other crops, managing project coordination, and disseminating findings to stakeholders. Industrial consultants Sogrape and Frutas Classe offer a user-centered perspective and expertise.



The partnership

The Project Leader team at **INESC MN** (Virginia Chu, João Pedro Conde) excels in developing microfluidic platforms for detecting single-strand DNA, antibodies, and small molecules. Their platforms integrate miniaturized photodetectors for optical transduction and innovative on-chip sample preparation methods. Recent research emphasizes microfluidics for cell lysis and detecting rolling-circle amplification (RCA) products in a microfluidic chip, laying the technological foundation for this project

The partner team from **BioISI**, Universidade de Lisboa (Margarida Fortes), the Plant Functional Genomics Group (https://ffgb.pt), collaborates on the project. Their expertise in grape maturation and stress response pathways provides well-characterized samples for device validation. The ongoing partnership between INESC MN and FFGB, particularly on microfluidic biochips for hormone monitoring in vines and grapes, enhances the project.

Dr. António Graça from **Sogrape** and Dr. Sérgio Constantino from **Frutas Classe** contribute industrial production knowledge and validation samples.

The teams at INESC MN and BioISI collaborated in project VineSense “Microfluidic biochip for the detection of stress biomarkers in vines and grapes” (FCT, 2021-2023). The team at Sogrape was an Associated Industrial Partner

The teams at INESC MN and Sogrape collaborated in project iGrape (EU, 2019-2022).

News

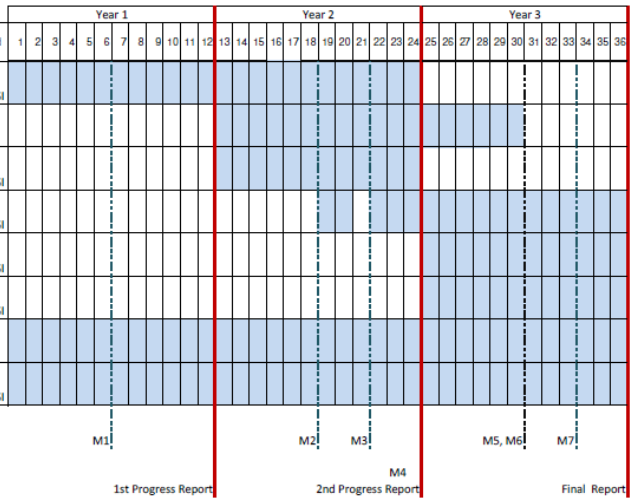
- On March 3, 2026, a remote meeting took place between Eng. António Graça and Dra. Ana Catarina Gomes from Sogrape and João Pedro Conde to discuss the interactions between the MIDIFRUIT project and the Sograpе research team.
- Inês Agostinho, a master´s degree holder in Biomedical Engineering from Técnico, Universidade de Lisboa, joined the INESC MN team of MIDIFRUIT on February 1, 2026, with a PhD grant from the project. Inês' research will focus mainly on the development of label free transducers for the nucleic acid detection platform.
- João Flores, a master's degree holder in Biomedical Engineering from Técnico, Universidade de Lisboa, joined the INESC MN team of MIDIFRUIT on January 1, 2026. João will lead the integration of the microfluidic chips into a portable platform.
- On October 23, 2025, João Pedro Conde and Margarida Fortes, together with three students, visited Frutas Classe, hosted by Dr. Pedro Bonifácio. After a presentation of the company, there were presentations by the INESC MN and FC teams, followed by a visit to the strawberry production fields and collection of healthy and diseased fruits.

On-going tasks

Project reference : MIDIFRUIT

Project title: Microfluidic platform for detecting fruit infections from production to post-harvest processing at the point of impact

Task Nº	Task Denomination	Person*month	Participant responsible for task	Acronyms of partners involved in task
1	MICROFLUIDIC GENE DETECTION ASSAY DEVELOPMENT AND DEVICE INTEGRATION	27,60	INESC MN	INESC MN, BioISI
2	DEVELOPMENT OF A PORTABLE POINT-OF-USE SYSTEM	20,00	INESC MN	INESC MN
3	POINT-OF-USE MICROFLUIDIC SYSTEM OPTIMIZATION AND CALLIBRATION	13,30	INESC MN	INESC MN, BioISI
4	CHIP IN THE LAB PERFORMANCE TESTS	17,30	INESC MN	INESC MN, BioISI
5	VALIDATION IN THE FIELD	7,30	BioISI	INESC MN, BioISI
6	PROOF-OF-CONCEPT EXTENSION OF MICROFLUIDIC SYSTEMS TO OTHER FRUITS	7,90	BioISI	INESC MN, BioISI
7	MANAGEMENT	3,00	INESC MN	INESC MN
8	DISSEMINATION AND PROMOTION	8,60	INESC MN	INESC MN, BioISI
		105,00		



M1 Proof of concept of functionality of integrated device (Month 6)
M2 Proof of concept of multiplex microfluidic device operation (Month 18)
M3 Proof of concept of portable DNA detection system (Month 21)
M4 Integrated device for genomic detection (Month 24)
M5 Detection of grape infection using the portable system (Month 30)
M6 Detection of grape infection using the portable system in the field (Month 30)
M7 Detection of infection in strawberries using the portable system in the field (Month 33)