# GOODFOOD


## In this Issue



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## The GoodFood 5th Newsletter

Welcome to the GoodFood's fifth Newsletter, which is regularly disseminated in order to keep you up to date on the achievements of the project.

The GoodFood project is an Integrated Project presented within the IST thematic area of EC VI FP and aims at developing a new generation of analytical methods based on Micro and Nanotechnology (M&NT) solutions for the safety and quality assurance along the food chain in the agrofood industry.

GoodFood is almost finished. The last months have been of crucial importance and have been devoted to conclude and optimize the activities expected within all GoodFood Workpackages and the Demonstration projects. In particular, the demo projects have given the opportunity to contact and to show the GoodFood results to companies and decision makers involved in food quality and safety activities.

The GoodFood consortium will continue to keep you updated with important news and events through the website (www.goodfood-project.org) also after the end of the project.

In this issue a detailed description of a multisensor miniturized gas and liquid chromatographic system, optimised for the control of the quality and safety of foods developed within GoodFood is reported.

The results of the demo projects launched last year are also described. In particular, three different demo activities have been carried out: two addressing the wine chain and one the fish chain. The demos carried out in collaboration with companies and Institutions of the specific sector have shown good opportunity for the exploitation of the technology developed during the GoodFood Project.

***Finally, we have the pleasure to announce the third GoodFood Open Day, which will be held in Bilbao (Spain) on September 12th, 2007. The event will be devoted to the fish food sector and results from the project on this subject will be presented. Relevant external end users and MNT developers in this area will be also invited.***

# GoodFood WP5:
## Multisensing Microsystems integration for food quality control

### THE QUALITY MONITORING SCENARIO

The monitoring of the quality and safety control in the agrofood industry is an up-to-date topic, because of the important issues of quality of life and health care as well as its possible industrial applications. Typical examples are the determination of the freshness of fish and the detection of contaminants in fruit (apples, grapes) and fruit juices (including wine). The organoleptic analysis, based on both analytical methods and trained inspectors who use odour and tongue evaluation, is the wider used method to define quality in foods. This organoleptic evaluation provides a Quality Index Method (QIM) but in both cases it is expensive and time consuming. Nowadays, there is strong requirement for developing a reduced size, low cost and portable high-performance systems for micro analysis. Generally, it is difficult to meet all the above-mentioned requirements, however remarkable progress has been made with the introduction of microsystem technologies (MST).

Here we propose the development of a multisensor miniturized gas and liquid chromatographic system, optimised for the control of the quality and safety of foods, in particular fish and wine, and arranged for future integration into a single intelligent system in order to simultaneously combine olfactive and taste effects. Chemical separation takes place in a miniaturised column for rapid analysis and analyte identification is performed by an adequate array of chemical microdetectors.

### The Miniaturized Multisensor Gas Chromatographic System (MMGCS)

The strategy has been the development of a system that doesn't compete with a classical analytical instrumentation (like gas chromatographs) in terms of resolution, sensitivity and accuracy, but rather an instrument where all the above mentioned characteristics are considered and well balanced towards the specific application. This was achieved by exploiting the innovative concept of a miniaturised system realised by matching a solid-state sensors array and a gas-chromatographic column (GCC), both realised using silicon micromachined components. This approach will benefit both from the high sensitivity and partial selectivity (spatio-chemical) of solid-state gas sensor arrays (including metal oxide-based gas sensors and cantilever devices) and of the enhanced selectivity (spatio-temporal) provided by the GCC. In fact, a series of partially or totally time-separated gases will reach the solid-state sensors array, simplifying the mixtures which are to be simultaneously classified and quantified.

### The MMGCS metal oxide gas sensors module

The metal oxide gas sensor module, was designed with the aim to provide reliable detection capability to the Miniaturized Multisensor Gas Chromatographic System (MMGCS). A low power micromachined gas sensor array was adopted as detection core of the module and the integration approach resulted in a high added value handheld system.

The peculiar solutions adopted, which permit to satisfy the design requirements, are:

• Unlike conventional GC systems, no carrier gas bottles are needed, since filtered air is used as carrier. The carrier gas is generated on board by means of the filter and moved through the system by the pump. This solution allows to keep the system compact and free from external gas utilities.

• A simplified injection system, relying on a three way valve, directly injects air containing flavours and gaseous emissions provided by food to the head of the separation column. This solution implements a simple and reliable sampling subsystem.

# GoodFood WP5:
## Multisensing Microsystems integration for food quality control

• No air sample pre-treatment is necessary, while standard analytical instruments involve long and complicated destructive food preparation processes.

• All the system components are miniaturized (e.g. the pumps and the valves) or micromachined (e.g. the columns and the detectors). The columns integrate a heater element for temperature modulation, therefore no column oven is necessary. The fluidic interconnections are integrated in a compact pneumatic interconnection block which allows to replace the different components in a quick and easy way, in order to test different setups and efficiently find the optimal one. These solutions allow to keep the system compact.

• The system relies on a few critical components, each one is managed by specific control electronics. Thanks to this the system, no trained personnel is required for use and no specialized technicians for maintenance.

• Specific signal processing algorithms and pattern recognition procedures will be developed to provide to the operator an output which is directly related to the food freshness.

The functional block diagram of the system is shown in Fig. 1.

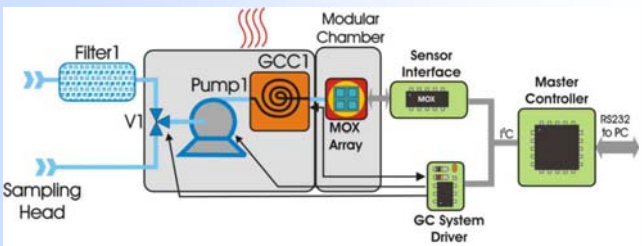


*Figure 1: Miniaturised Multisensor Gas Chromatographic System (MMGCS) schematic*

The prototypal implementation of system pneumatic reported in the Fig. 1, is shown in the following picture (Fig. 2).

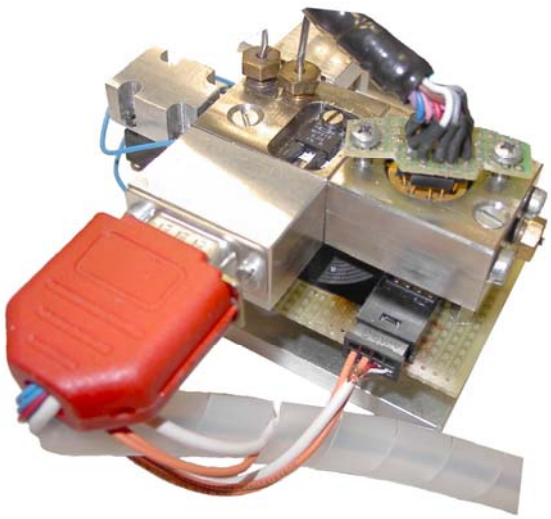

*Fig. 2. Picture of System pneumatics prototype*

To test the functionality of the MMGC system extensive measurement campaigns have been performed, where mixtures of fish freshness target gases TMA, DMA, NH3 (Trimethylaminuria, Dimethylamine, Ammonia), variable in composition and concentration of each component, have been provided to the system to evaluate its capabilities. In fact these kind of ammines have been identified as freshness markers from WP5 consortium, suitable for advanced quality assessment.

In Fig. 3, the raw output from one sensor of the system array is reported; the three well separated signals of the fish freshness target gases are visible, at the very low concentrations analyzed (few part per millions, ppm).

# GoodFood WP5:
## Multisensing Microsystems integration for food quality control

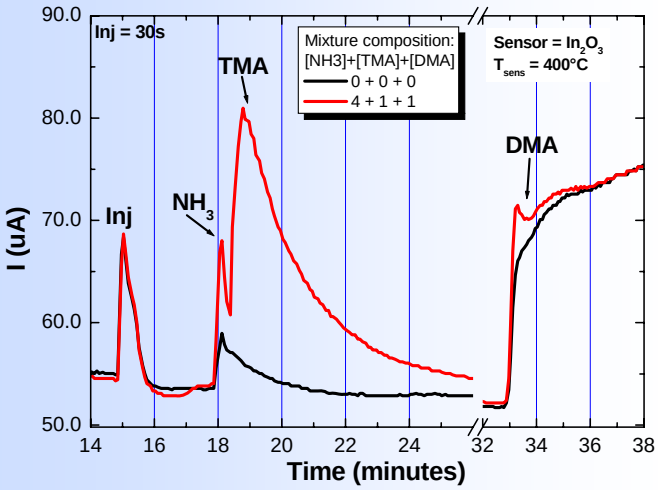


*Fig. 3. System raw signals*

•The system has been also tested in a preliminary measurement campaign in real working conditions with real fish samples. Fig. 4 show the results obtained in this preliminary campaign, where the system has been able to track the increase in TMA concentration in real fish samples at different storage times.

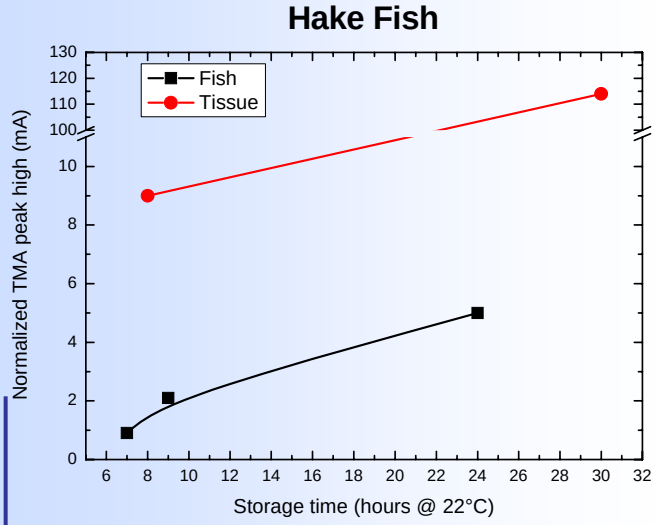


*Fig. 4: TMA trend in Hake fish vs storage time*

### The GoodFood approach

The miniaturization of liquid chromatography (LC) separation systems by means of Si-based microfabrication technologies introduces potential multiple advantages, such as higher sensitivity, low operating pressures and significant reduction of solvent and sample consumption. These new features could enable portable and/or disposable LC systems for field tests and ubiquitous monitoring with the aim of bringing the laboratory to the sample, instead of the sample to the laboratory, which would be impossible with today's bulky laboratory LC instruments.

The identification of quality markers for wine represents a more interesting challenge owing to real complex matrix represented by wine and also because wine headspace is characterized by different and subjective-classified compounds. Nevertheless, a set of useful markers were defined; in particular Acetic acid (CH3CO2H) , Sulphur dioxide (SO2) and Hydrogen sulphide (H2S) have been selected as typical secondary produced compounds that can express particular and stressed fermentation conditions. The preliminary architecture and solutions here reported were chosen in order to characterise each module and to satisfy the application specific requirements, like small size, simplicity and user-friendliness with respect to standard laboratory equipment. The proposed system allows replacing the different components in quick and easy way, in order to test different setups and to efficiently find the optimal one.

### Fabrication technologies and results

The microsystem mainly consists of three modules: i.) the separation module that integrates a heater element for temperature control and microelectrodes suitable for a pre-screening of the analytes; ii.) the electrochemical sensors array (potentiometric and voltammetric); iii.) the read-out electronics.

# GoodFood WP5:
## Multisensing Microsystems integration for food quality control

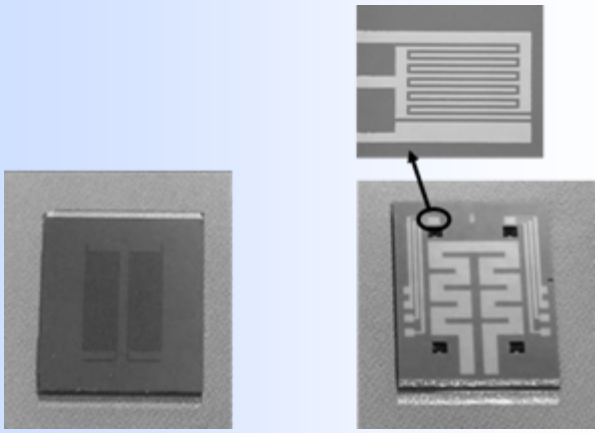

*Fig. 5: Front (left) and back (right) side of the microseparation module with an enlarged view of the sensor*

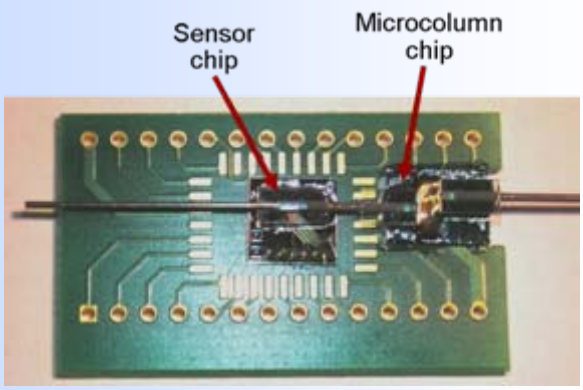


*Fig. 6: Package of the separation module with the sensor*

The sensors responses showed good stability and reproducibility during different measures days. As an example, Fig. 7 shows the potentiometric sensor data analyzed by PLS technique, using Leave-One-Out technique for cross-validation. A clear classification can be obtained for different compounds, with 3 different directions. The system also showed a good capability to recognize the exact amount of each analyte, with a partial overlap in the centre of the plot at very low concentrations.

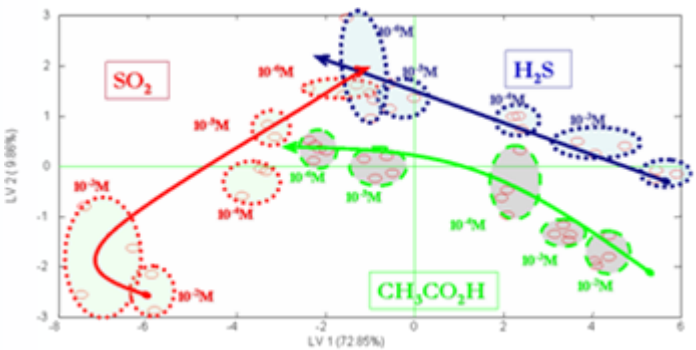


*Fig. 7: PLS scores plot of measures with identification of wine defects and relative concentrations*

# GoodFood Demo Projects

## Demo 1: "Monitoring for the chilled/frozen fish logistic chain based on Flexible Tag Microlab (FTM) system"

**Demonstration and Validation of a Flexible Tag Datalogger for the Fish Logistic Chain**

One of the main targets of the GoodFood project (FP6-IT-1-508774-IP "Food Safety and Quality with Microsystems") was to improve the food quality and safety within the complete logistic chain (i.e. transport, storage and vending) through the development of a microlab on a flexible tag (FTM). The heart of this food tracing system is a combined Reader/FTM system integrating physical (temperature, relative humidity and light) and gas sensing, data evaluation and storage, as well as a RFID communication module.

The main objective of this demonstration project is the implementation of a temperature and relative humidity versus time monitoring system logistic chain, based on the use of the Flexible Tag datalogger developed within the GoodFood project.

These smart tags are integrated into a data communication environment for online monitoring during the fresh fish logistic chain. The idea is to enable a future generation of producers and logistic groups to trace the product at any time, if needed, and to allow consumers to check the complete history of a certain product. Moreover, using this kind of system consumers will be protected from the consumption of unsafe fish.

RFID technology in the 13.56 MHz band was chosen since it is the best compromise for integration on a flexible tag. Furthermore, in order to be compliant with recent RFID developments the ISO 15693 standard was selected. The system is compatible with commercial readers like the Texas Instruments TRF7960_EVM used for this demonstration. A picture of the tag prototype, developed on PCB substrate, together with the commercial TI reader used for this demonstration is shown below.

*Figure 8: Tag prototype, developed on PCB substrate, together with the commercial TI reader used for this demonstration.*

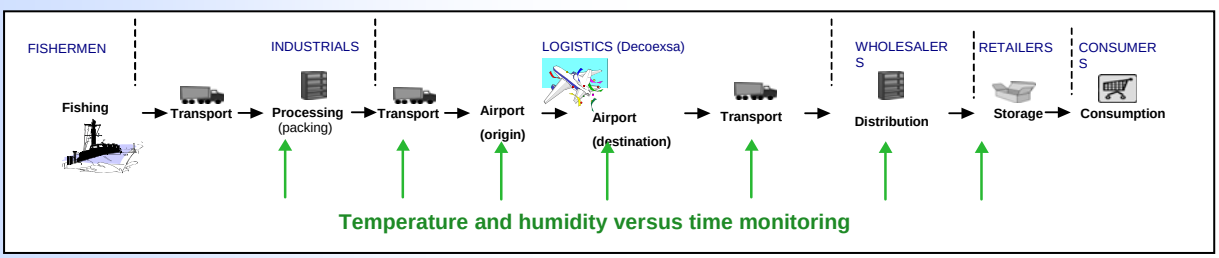


*Figure 9: Illustration of the fresh fish logistic chain*

# GoodFood Demo Projects

## Demo 1: "Monitoring for the chilled/frozen fish logistic chain based on Flexible Tag Microlab (FTM) system"

The demonstration is being carried out along the fresh fish logistic chain from South Africa to Europe. The chain, illustrated in the Figure 9, begins with the fish capture and transport to the processing factory in refrigerated trucks. At the factory the fish is gutted, sized and packed in polystyrene boxes. A refrigerated truck transports the fish boxes to the origin airport in South Africa in a journey which can last for up to 12 hours. The flight to the destination airport in Europe is about 12 hours long. In the logistic company in Europe (Decoexsa) the fish boxes are re-organised according to their destination and re-expedited to the wholesalers. Finally another refrigerated truck transports the fish boxes to the retailers. The temperature and humidity control begins in the processing factory and continues at each step of the food-chain and extends to the retailer distribution. Important traceability data such as origin, specie, capture data, etc. are also recorded in the tag and traced along the whole logistic chain according to the Tracefish Standards.

The innovative system validated in this demonstration project:

• allows tracing if the expected temperature range were maintained on the way from the producer to the consumer

• provides real-time traceability information of the product to the different fish distribution chain links

• allows getting a better safety and quality control along the complete fish logistic chain

• helps to improve the competitiveness of the fish companies and improve their logistic management

• reinforces the confidence of the consumers in the fish logistic chain

In summary, this safety and quality control system supposes and important impact for the fish company, that will be able to offer a product with added value compared with the rest of the market. From a general point of view, the online monitoring system proposed fits with the IST vision of "anywhere anytime access to IST services for all".

### PARTNERS and DEMO PROJECT STRUCTURE

**TEKNIKER** – GoodFood Partner

**AZTI-Tecnalia** – GoodFood Partner

**University of Barcelona** - GoodFood Partner

**DECOEXSA** – Demo End-User

**Microelectronica MASER** – Demo End-User

# GoodFood Demo Projects

## Demo 2: "GoodWine: Flexible tag datalogger for wine quality control"

### GoodWine aims

The demonstration project GoodWine applies the GoodFood approach to the specific case of wine, which is a high-quality product requiring an accurate monitoring trough the logistics phase. GoodWine aims at showing the use of Smart Tags for the traceability and for the monitoring of some external parameters related to the quality of bottled wine, through the complete logistics chain: from the producer to the consumer. Figure 10 shows a Smart Tag prototype attached to a wine bottle by means of a packaging collar.

*Figure 10: The smart tag integrated in the bottle of wine*

*Figure 11: the infrastructure for wine quality and security monitoring*

### The smart tag

The proposed Smart Tag features a set of sensors, adding some new functionalities which are not available on conventional barcodes or RFID tags. In particular, the Tag for wine bottle monitoring is equipped with sensors for temperature, relative humidity and light intensity; these are parameters which can be indicative of bad storage of the product, resulting in a loss of quality and a damage for both the consumer and the producer.

The monitored values are stored in the Smart Tag memory and can be recalled at different logistic stages, or at the retailer, by the customer himself. In fact, the Smart Tag can be read-out by means of a Smart Phone or a PDA running a specifically developed software.

# GoodFood Demo Projects

## Demo 2: "GoodWine: Flexible tag datalogger for wine quality control"

**The scenario**

In the proposed scenario, after the bottling phase the bottle is equipped with a Smart Tag containing a set of information concerning the production, the fermentation process and the ageing phase in the cellar. During the transport and storage, the Smart Tag tracks both the logistics information as well as the environmental conditions the bottle is exposed to, by means of the integrated sensors. This will allow the consumer, both during and after the purchase, to know all the data characterizing the history of the single bottle, from the producer to the retailer.

Furthermore, using an individual ID stored in the Smart Tag memory, it is in fact possible to have access via Internet (with a PC, Smart Phone or PDA) to a vast set of information on the product (e.g. analyses performed in the vineyard or in the cellar, images and videos on the production site, data on the transport and storage, nutrition facts and wine composition, etc.), which is stored on a remote server.

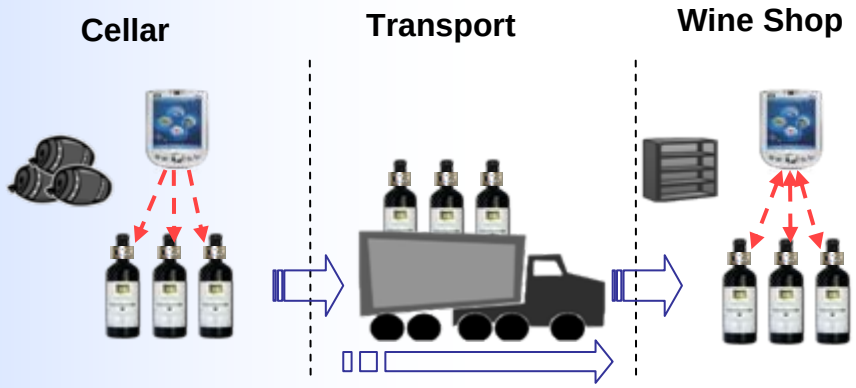


*Figure 12: Logistic Scenario*

**PARTNERS and DEMO PROJECT STRUCTURE**

**SSSA** – GoodFood Partner

**CNR IMM Bologna** – GoodFood Partner

**Synapsis** - GoodFood Partner

**ModulGraph** – Demo End-User

**Fattoria Poggio Gagliardo** – Demo End-User

# GoodFood Demo Projects

## Demo 3: "Ambient Intelligent Site for the vineyard"

### OBJECTIVES and SCOPE

After the deployment of the demo sites in the University of Florence Greenhouse (June 2005) and in the Montepaldi vineyard (October 2005) and in the Montepaldi cellar (June 2007), the objectives of this demo sites activity are to extend the experience achieved from actually deployed test sites, demonstrating the effectiveness and the potential of the developed infrastructure and components. The scope is primary to increase the number of Pilot Sites on the European territory, establishing a number of partnership both with research centres and with farming industries, in order to involve more people studying and applying mathematical models using continuous, real time distributed data from one side and to share the system potentialities with farmers to directly improve the wine production, and fit the system to the real end user requirements. The intrinsic scalability of the developed technology will allow to create a network for sharing and exchanging knowledge and experiences on the adoption of Ambient Intelligence (AmI) platforms and data analysis models for food chain quality & safety monitoring, in different kinds of vineyards, from sands vineyards near the sea, to clayey grounds onto hills.

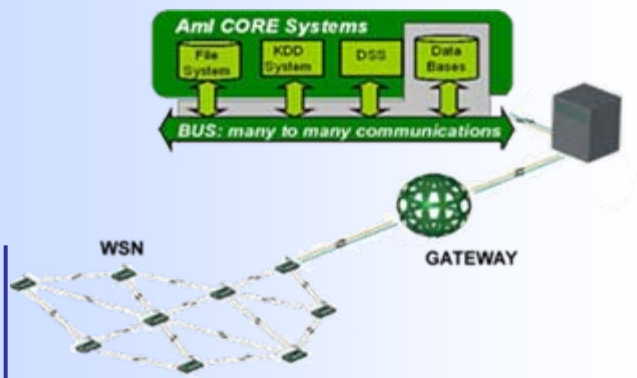


*Figure 13: AmI infrastructure*

Our expectation deploying the system into different kind of vineyards is to highlight differences in grape production, pathogens' attacks, water management and plants' physiological activities and monitoring and controlling them using the same sensors, the same system and the same user interface.

The possibility to extend the partnership to a number of actors and final user will also allow to properly tune the application in order to fully satisfy the User's needs, with easier and more powerful interaction models, and to build an experienced know-how to develop more application oriented industrial devices.

*Figure 14: AmI node in the vineyard*

### PRELIMINARY RESULTS

Since the deployment of demo sites was carried on in July, great part of the most interesting plants growing phase was lost for year 2007 and few considerations can be done on the impact of the vineyard monitoring system on the wine production: nevertheless, significant results can be shown from the application point of view.

# GoodFood Demo Projects: “Ambient Intelligent Site for the vineyard”

Two new pilot sites were deployed, in addition to the previous one in the Montepaldi vineyard and the new one in the cellar: one is in the Chianti area in Tuscany, in a main farming industry and one in France, in an advanced wine research centre; this means that the deployed systems will be evaluated both from a scientific point of view and from an industrial point of view.

Besides, all these pilot sites have many nodes and sensors to characterise in detail the vineyards: in particular the one deployed in Pech Rouge (Gruissan, France) is composed of 15 nodes and 68 sensors: this means that the vineyard will be highly and densely monitored, with high precision and detail, and this could be an important test site for scientific experiments and studies.

The pilot site in the Chianti area is smaller, with 10 nodes and 48 sensors, covering a greater area (2 hectares): nevertheless they will be enough to acquire a significant amount of data, to completely monitor the vineyard and its parameters, even due to strategic nodes positions in the vineyards themselves, and to reduce costs for farmers.

The monitored covered area has remarkably increased, from about 1 hectare in Montepaldi, to more than 2 hectares in the new pilot sites, due to the new RF section on MIDRA mote and to the bipolar antennas.

The deployment in the Pech Rouge vineyard (France) has shown that this system is portable and exportable, not only in Italy, but in other countries of the European Union, where the GPRS coverage is guaranteed: in addition, since the chosen GPRS provider is a French one (Orange), during the test period in Italy, all the data where transmitted via GPRS in Roaming Mode.

## PARTNERS and DEMO PROJECT STRUCTURE

**MIDRA Consortium** - GoodFood Partner

**EADS** - GoodFood Partner

**HTA** - GoodFood Partner

**SSSA** - GoodFood Partner

**Synapsis** - GoodFood Partner

**Tyndall National Institute** - GoodFood Partner

**Azienda Agricola Castello di Ama** – Demo Site End-User

**Cemagref (Unité Expérimentale de Pech Rouge)** – Demo Site End-User

# Bilbao Open Day: Rapid detection systems for safe and traceable seafood products

On September 12th 2007, an Open Day Workshop will be held in Bilbao with the theme "*Rapid detection systems for safe and traceable seafood products*".

This is the third workshop organized by the GoodFood consortium. The first two GoodFood Workshops were devoted respectively to microtechnology in the agrofood field with particular attention to the vineyard and microtechnology for the milk and dairy food chain. The workshops were planned for contributing both to the dissemination of the aims and achieved results of the project and also to the training of researchers and industrials through tutorials given by key persons from different countries in the two specific sectors.

The third edition of the Open GoodFood Day will be devoted to the presentation of the results achieved within the project concerning new microsystems developed for fish quality and safety along the food chain.

External key persons on the fish field arel also invited and will present other relevant topics.

The presentations given during the Workshop by the different speakers will be available on the GoodFood web site, in the "Training activities" section.

## Agenda

| | | |
|---|---|---|
| 9:00-9:30 | Registration | |
| 9:30 | Opening and Welcome address | |
| *10:00-10:20* | Rapid detection of Listeria & Salmonella in fish products | Mary Manning (Tyndall, Ireland) |
| *10:25-11:00* | Miniaturized gaschromatographic system for the evaluation of fish freshness: demonstration for volatile amines | Gian Carlo Cardinali (CNR-Bolonia, Italy) & Alex Barranco (AZTI-Tecnalia, Spain) |
| *11:00-11:20* | DNA tools for traceability | Miguel Angel Pardo (AZTI-Tecnalia, Spain) |
| *11:20-11:45* | Coffee and poster session | |
| *11:45-12:05* | Traceability and logistics for imported fish to EU | José Mª Navajas (DECOEXA, Spain) |
| *12:10-12:30* | Demonstration project: flexible tag for the fish logistic chain | Estefania Abad (Tekniker, Spain) |
| *12:35-12:55* | New needs for sensing in fish farming | Mª Carmen Marín (Culmarex S.A., Spain) |
| *13:00-13:20* | Traceability in different fish chains and the introduction of in line or at line sensors and tagging devices | Erling Larsen (DIFRES, Denmark) |
| 13:30-15:00 | Lunch for all attendees | |