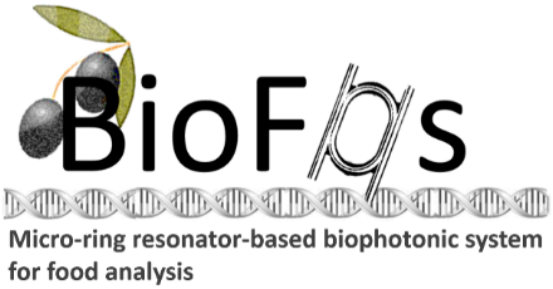
Publishable Summary



BIOFOS

Micro-ring resonator-based biophotonic system for food analysis

Grant Agreement No. 611528
Project duration: 36 months
Project website: http://www.ict-biofos.eu/

With a market share of 14.5 % of the total manufacturing turnover (€917bn for the EU-27), the food industry is the second largest sector in the manufacturing industry of EU, consisting of about 310,000 enterprises. With 4.8 million employees, the food industry's share of employment is about 14% of the total manufacturing sector, of which 62% are employed in SMEs (undertakings of less than 250 persons) representing virtually the total number of enterprises. Despite the fact that Europe's food and drink sector has always been a pillar of the EU economy, current methodologies for detection of food contamination based on heavy analytical tools cannot guarantee a safe and stable food supply. The reasons are the complexity, the long time-to-result (2-3 days) and the cost of these tools, which limit the number of samples that can be practically analyzed at food processing and storage sites. The need for screening tools that will be still reliable but simple, fast, low-cost, sensitive and portable for in-situ application is thus urgent.

BIOFOS project aims to develop a simple, fast, low-cost, sensitive, portable and reliable, screening tool for in-situ detection of food contaminations in nuts, olive oil and milk. During the first year of BIOFOS we have achieved progress on all different technological platforms, the photonic, biological, nanochemical and fluidic of LoC systems.

The main objectives of the BIOFOS project are listed below.

- Development of monolithic photonic circuits for label-free, high-throughput optical biosensing at 850 nm based on 1:8 MMI couplers and 8-fold MRR arrays for operation.
- Hybrid integration of actives elements (VCSEL and photodiode arrays) on TriPleX boards using flip-chip bonding and butt-coupling techniques.
- Design and production of aptamers for highly-selective detection of food contaminants and lactose in milk.
- Development of effective techniques for functionalization of sensor substrates and immobilization of biomediators (aptamers).
- Development of robust techniques for regeneration of biomediators (aptamers) and reusability of sensor arrays.
- Development of microfluidics for solid and liquid phase treatment.
- System integration in a cost-effective, reusable LoC system and system validation in real settings.

Work performed and results achieved

The main technical achievements for the Year 1 of the Project are summarized below per work package (WP3-WP9).

Work-package 3: Innovation chain, stakeholders' requirements & specifications, System design and methodology for integration and packaging processes

Activities within WP3 aiming in defining the innovation chain of BIOFOS system, and the stakeholder's requirements involved in the relative food sectors, enable the definition and design of the system specifications and packaging methodologies of the system, as well as evaluation of the system through system level modelling and simulations.

Within the first period of the project, IRTA and COVAP in collaboration with the rest of the consortium identified and interviewed stakeholders of 4 different levels involved in olive oil, nuts and milk sectors. Through this activity, the real needs and requirements of stakeholders were identified. The outcome of this study has confirmed the need of the market for a compact, simple, specific, sensitive and cost effective system for food analysis such as BIOFOS. These needs and requirements will be used as the starting point for the definition of the BIOFOS system specifications thus enabling the successful implementation of the BIOFOS sensor as a newly developed, fast, sensitive and user-friendly toolkit in the food quality and safety market.

Additionally the design and actions towards the establishment of the system-level specifications of the BIOFOS system, started and the most crucial interfaces of the system have been identified -i.e. the interface between the optical and microfluidic chip, microfluidic-sample-pretreatment unit interface and the interface between the optoelectronic elements and the passive optical board- and specific efforts started for their design.

Work-package 4: Design, fabrication and regeneration of biomediators

WP4 is dedicated in the design, development and characterization of the bio recognition elements (aptamers) that the BIOFOS system relies on in order to target in high specificity and selectivity analytes such as mycotoxins, insecticides antibiotics and heavy metals found in olive oil, nuts and milk samples.

Within the first period of the BIOFOS project, four (4) "known" aptameric sequences have been selected and characterized in terms of specificity and selectivity against the mycotoxins OTA, AFM1, AFB1 and copper ions. Now, BIOFOS is in progress on validating the binding efficiency of the aptamers on target analytes extracted from real food samples. In addition, an aptameric sequence against Lactose is just to be developed through the SELEX procedure.

Work-package 5: Photonic platform of the biosensor system

Within WP5, the waveguiding structure of the photonic integration platform (TriPleX) and the photonic chips, as well as their integration with the microfluidic chips are designed and fabricated. Within period 1, the involved partners designed and developed the photonic platform and completed and started fabricating the first designs on individual components. In addition, the design of the hybrid-integration process and electronics has started. In parallel, the corresponding beneficiaries have progressed on the preparation of appropriate setups for the experimental characterization of the optical and bio-chips.

Work-package 6: Functionalization of the sensor surface/immobilization of the biomolecules

Activities within WP6 are devoted in the functionalization of the sensor surface and immobilization of the bio-recognition elements (aptamers) onto it either though chemical processes or using direct laser based techniques. Within the first period of the project, the partners involved with these activities achieved to successfully immobilize aptamers targeting Ochratoxin A of on the Si_3N_4 surfaces-sensing area of the chip-, directly based on laser techniques. In parallel, functionalization processes

Work-package 7: Microfluidics and system electronics

The activities within WP7 are related to the development and implementation of microfluidic platform of the BIOFOS system. This includes, the development of the fluidic sample pretreatment units for olive oil, nuts and milk, the development of the microfluidic analysis cartridge and of the regeneration module. One major objective also of this WP is the development of the electric platform for controlling the different modules and user interface.

Within the first year of the project, the consortium worked closely in defining the pretreatmnent protocols that will be employed for the extraction of the analytes from the three different food samples and defined the process for their analysis. Additionally, different modules of the microfluidic platform were designed and started to be fabricated, while the master plan for the electronics as well as the first concept of the individual PCBs is defined.

Work-package 8: Performance evaluation, and system integration and validation in real settings

WP8 is devoted to the characterization and evaluation of the performance of the biochips (chemically modified with aptamers optical chips), the integration of the system components in a single box, the definition of the testing procedures and finally to the validation of the BIOFOS system performance in lab and real field.

Although, this WP starts officially after the first year, the consortium partners have already proceed in defining major working lines especially in guidelines, protocols and specifications for integration and testing procedures aiming to the smooth start of WP8.

Work-package 9: Exploitation, standardization & dissemination.

The main objectives of WP9 are clustering with relevant EU projects, dissemination and exploitation of project outcomes through interactions with industry, academia, and the scientific community, and planning for exploitation of BIOFOS technology in commercial applications. Protection of intellectual property generated within BIOFOS is also important for the subsequent commercial exploitation of the project results. During the first period of BIOFOS, the consortium members achieved one publication in journal. The concept of BIOFOS as well as the first results achieved for the individual platforms developed within the project were disseminated through a number of presentations and posters in international and national conferences and workshops. Finally, a number of clustering activities occurred between the BIOFOS and other projects of the MNBS group (FOODSNIFFER, LOVEFOOD and SYMPHONY).

Contractors involved

	INSTITUTE OF COMMUNICATIONS & COMPUTER SYSTEMS/NATIONAL TECHNICAL UNIVERSITY OF ATHENS	GR
	LIONIX BV	NL
	CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA	CH
	UNIVERSITÉ DE PERPIGNAN VIA DOMITIA	FR
	BIOMEDICAL RESEARCH FOUNDATION, ACADEMY OF ATHENS	GR
	SURFIX BV	NL
	UNIVERSITY OF WAGENINGEN	NL
	INSTITUT DE RECERCA I TECHNOLOGIA AGROALIMENTARIES	ES
	SAXION UNIVERSITY	NL
	SOCIEDAD COOPERATIVA ANDALUZA GANADERA DEL VALLE DE LOS PEDROCHES	ES

Coordinator contact details

Assoc. Prof. Ioanna Zergioti
National Technical University of Greece (NTUA)
Iroon Polytechneiou 9, 15780, Athens
Tel.: +30 210-772 3345
e-mail: zergioti@central.ntua.gr