Web: http://www.toxdtect.eu
Final video: https://www.youtube.com/watch?v=qJUj_-XftCE

PUBLISHABLE SUMMARY

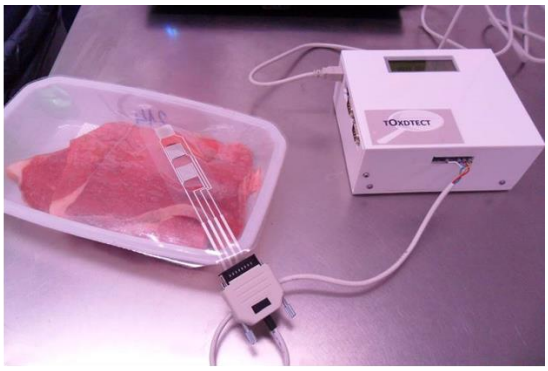
Background

In the last 10 years, EU beef production has declined nearly 15% due to decreased consumer demand because of animal disease issues. As the concern about food poisoning is growing among consumers and Food Standard and safety agencies, the food industry is called to bring in changes. On the other hand, current food labelling systems are ambiguous and fail to deliver accurate information concerning food quality and expiration dates. The ambiguity and diversity of traditional labels creates confusion between consumers (40% founds labels difficult to understand), often bringing them trusting more their eyes than the information reported in the label. In highly perishable products as fresh meat, the red colour is often used as the primary indicator of freshness and quality, ignoring the expiry date. This situation leads to:

- → Generation of high amounts of food waste (89M tonnes/year in the EU). Meat accounts for the 25% of total waste in the food industry. The 20% is due to misinterpreting of expiry dates.
- → Safety risks for improper storage of perishable food (more than 23M people/year fall ill from unsafe food in Europe).
- → Emission of 170M tonnes of CO_2 and consume of 261M tonnes of resources.

The aim of TOXDTECT project is to develop an Intelligent Packaging solution for fresh bovine meat products. The technology is based on the identification of specific volatile organic compounds (VOCs) produced inside the packaging during microorganisms' growth. These compounds accumulate in the headspace and are detected by VOCs-sensitive sensors printed on the inside of the packaging film. The signal coming from the sensors can be related to the presence/concentration of the specific analytes. The sensing platform is formed by an array of three screen-printed electrodes modified with conductive polymer inks. The signal coming from the interaction between VOCs and

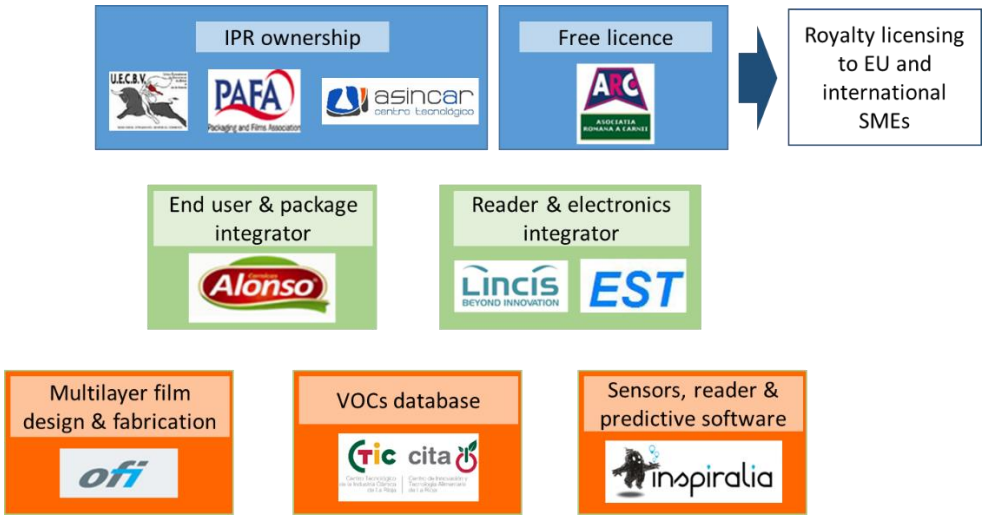
polymer inks is recorded by an external device where data are processed. A suitable predictive software based on data mining algorithms finally correlates the sensors signal with the remaining shelf-life of meat (i.e., number of days during which meat is still safe to be consumed).
Compared to existing test methods like sensory and microbiological analysis which are costly and destructive, our solution offers a non-destructive, accurate and cost-effective method to determine the integrity of packed meat and predict its real freshness.

By providing a reliable method for the determination of beef quality and shelf-life directly from the product we will be able to:

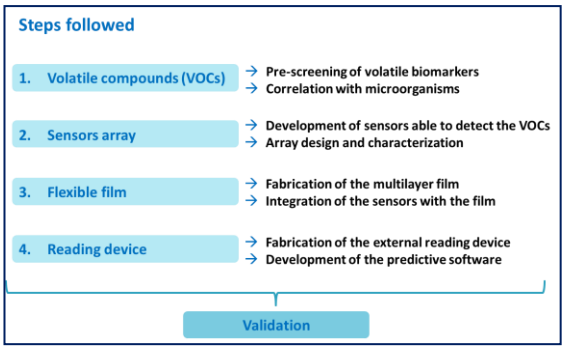
- → Provide to consumers a clear labelling system. They will no longer be confused with 'best before' and 'consume by' dates since the information they get is provided in real time from the real product they are purchasing.
- → Follow-up the quality status of single packages through a non-destructive technique.
- → Inform consumers about the freshness of packaged meat, since the signal coming from the sensors will be affected by any fluctuation of the cold supply chain (satisfying the need of a "real date label").
- → Reduce food waste at grocery stores and in consumers' homes.
- → Reduce food poisoning cases caused by defective packaging or incorrect manipulation in the distribution chain.

TOXDTECT proposal has been promoted by 4 Industrial Associations of SMEs, ASINCAR, Asociación de Industrias Cárnicas de Asturias (ES), PAFA, Packaging and Films Association (UK), UECBV, European Livestock and Meat TradeS Union (BE) and ARC, Asociatia Romana a Carnii (RO), along with 3 industrial SMEs, LINCIS, Soluções Integradas para Sistemas de Informação, Lda (PT), EST, Electrochemical Sensor technology Ltd. (UK) and CALON, Industrias Cárnicas Alonso (ES) acting as end users, and 3 Research Centers, CTIC-CITA, Centro Tecnológico de la Industria Cárnica de la Rioja (ES), Osterreichisches Forschunginstitut fur Chemie und Technik, OFI (AT) and Tecnologías Avanzadas Inspiralia S.L. (ES).



Project Objectives

The objectives of TOXDTECT project are:



- → Identification of volatile metabolites representative of beef meat spoilage and indicators of meat quality.
- → Low cost printing fabrication of sensors easily embedded within the meat package.
- → Study and development of a cost-effective production technology for flexible packaging multilayer film.
- → Development of a suitable external reading device able to receive data from the sensors.
- → Development of a decision making system (software) for meat quality assessment based on predictive algorithms

Achievements

TOXDTECT project was officially started on the 1st of November 2013. The project is structured into 8 work packages and the planned duration is 36 months. The main results achieved during this time can be summarized as follows:

- → We started analysing the VOCs produced by red meat under specific conditions (fixed temperature, MAP, etc.), during a defined time window (14 days from packaging). Between all VOCs identified, 3 of them were selected thanks to their higher correlation to microorganisms' growth.
- → We evaluate different analytical protocols and sensing strategies compatible with the objectives of the project and we select the most suitable one.

- → Several water-based conductive polymer inks were formulated and tested in presence of the pre-selected VOCs. The most sensitive and selective inks were used to modify arrays of interdigitated electrodes directly printed on flexible substrates.
- → The optimal components of the multilayer film were selected after an extensive testing of their permeability and migration performances. The film structure is based on an outer high-barrier layer, where the array and sensors were embedded, and an inner layer permeable to the 3 selected VOCs.
- → The arrays were integrated with the multilayer film by screen printing technology, modified with the polymer inks and sealed to meat trays. Small scale batches were used to check the robustness and general applicability of the system.
- → Preliminary hardware electronic studies were done for the development of the external reading device that includes the interface with the package sensors, the conditioning electronics of the sensors, the microcontroller running the decision software, the display, the control software of the device and the user interface of the application. All these elements were already integrated into a small portable device and the entire electronic reading system was validated and integrated with the rest of the sensing system.
- → Pre-processing and predictive algorithms based on soft computing and data mining techniques have been designed and developed to get a good accuracy when predicting meat quality. The data mining models and the whole intelligent software were validated using the real dataset formed by a set of 8 different pieces of meat and during a time window of 14 days of data collection.
- → Validation of the whole system will be done for different batches of beef meat in order to demonstrate that the output of the system (sensors signal) is reporting the same quality state and shelf life of meat as conventional analyses (gas chromatography).

Consortium Members

PARTNER	SHORT NAME	COUNTRY
Asociación de Investigación de Industrias Carnicas del Principado de Asturias	ASINCAR	ES
Packaging and Films Association	PAFA	UK
European and Livestock and Meat Trades Union	UECBV	BE
Romanian Meat Association	ARC	RO
LINCIS. Solucoes integradas para Sistemas de Informacao Lda.	LINCIS	PT
Electrochemical Sensor technology Ltd.	EST	UK
Carnicas Alonso	CALON	ES
Asociación para la Investigación de la Industria Cárnica de la Rioja	CTIC	ES

Österreichisches Forschungsinstitut für Chemie und Technik	OFI	AT
Tecnologías Avanzadas Inspiralia	INSP	ES

For further information contact with:

Juan Diaz Garcia
Asociación de Investigación de Industrias Cárnicas del Principado de Asturias/ ASINCAR
Tel: *+ 34 985 74 45 18*
Fax: *+ 34 985 74 35 12*
E-mail: *juan.diaz@asincar.com*

TOXDTECT Project has received funding from the European Union's Seventh Framework Programme managed by REA Research Executive Agency, under Grant Agreement n° [603425].

SEVENTH FRAMEWORK PROGRAMME