ANUAL REPORT
INSTITUTO DE BIOTECNOLOGÍA VEGETAL

UNIVERSIDAD POLITÉCNICA DE CARTAGENA

2016

During 2016, several important events occurred at the Instituto de Biotecnología Vegetal (IBV). The former director, Professor Francisco Artés Calero, resigned from his position as he retired from his job full professor to become emeritus. After the new elections, I assumed the direction with several new developments ahead.

From the early days, the IBV comprised seven research units. After the request of a group of colleagues from soil sciences, a new unit of Ecology and Soil Biotechnology, was created as part of the Institute in December 2016. It has five new scientists, Prof. Angel Faz, Prof. José Álvarez Rogel, Dr. Héctor Conesa, Dr. Raúl Zornoza and Dr. Martín Soriano.

While the IBV has been located at the I+D+i building since 2009, our quest has been to relocate to the Alfonso XIII campus. Finally, in 2016 the Rectorate included the IBV in the major plan to restructure the Alfonso XIII campus. Pending economical assignments, we should be relocating in the foreseeable future.

The Consejería de Empleo Universidades y Empresa opened a call to give formal training to students graduated from the professional training program and the IBV benefited from those initiatives that were open in 2016 and started in 2017. Becoming a center for professional training has been an important step.

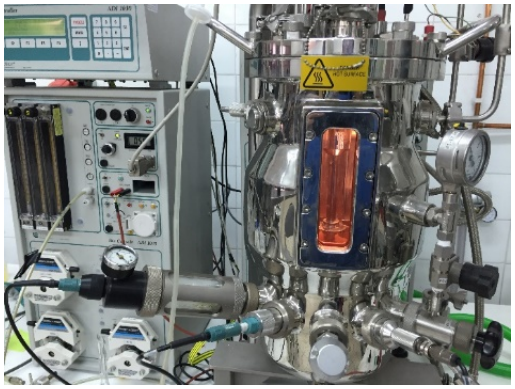
Altogether during 2016 the scientific output and extramural funding obtained by the different units maintained the levels of previous years. We expect to increase our capacity in the future implementing further our philosophy of cooperation, both for problem solving and in grant applications and research and development projects.

Marcos Egea Gutiérrez-Cortines

Full Professor of Genetics

Director Instituto de Biotecnología Vegetal

BIOTECHNOLOGICAL PROCESSES, TECHNOLOGY AND ENGINEERING



Description of main results

Five articles have been published in international journals (LWT-Food Science and Technology; Frontiers in Microbiology-Section Food Microbiology; and Food Engineering Reviews) with high impact factor (first quartile), and 3 patents have been submitted. In international congresses, 4 communications have been presented to the VIII Iberian Congress / VI Ibero-American Congress of Refrigeration Sciences and Technologies - CYTEF 2016 (Coimbra, Portugal) and to the VIII International Postharvest Symposium: Enhancing Supply Chain - ISHS 2016 (Cartagena, Spain).

1. Projects

New corrugated cardboard active packaging for doubling shelf-life of fresh fruits and vegetables — FRESHTRAY", Fase – 1. Horizon 2020; Call: H2020-SMEINST-1-2016-2017; Type of action: SME-1 (*Proposal number: 744241; Activity: SMEInst-07-09-2016*); Topic: SMEInst-02-2016-2017 — Accelerating the uptake of nanotechnologies advanced materials or advanced manufacturing and processing technologies by SMEs. Participants: UPCT and SAECO Company (Molina de Segura, Murcia), 71429 €. 2016-2017. Principal investigator: López Gómez, A.

Innovative stunning technology based on a natural anesthetizing agent on ice to improve animal welfare and extend shelf-life of farmed fish — ICE2LAST", Fase – 1. Horizon 2020; Call: H2020-SMEINST-1-2016-2017; Type of action: SME-1 (*Proposal number: 736169; Activity: SMEInst-1-08-2016)*; Topic: SMEInst-08-2016-2017 – Supporting SMEs efforts for the development - deployment and market replication of innovative solutions for blue growth). Participants: UPCT and CUBI-PLAYA S.L. Company (San Pedro del Pinatar, Murcia). 71.429 €. 2016-2017. Principal investigator: López Gómez, A.

2. Papers

Sánchez-Rubio, M., Taboada-Rodríguez, A., Cava-Roda, R.M., López-Gómez, A. and Marín-Iniesta, F. 2016. Combined use of thermo-ultrasound and cinnamon leaf essential oil to inactivate *Saccharomyces cerevisiae* in natural orange and pomegranate juices. LWT-Food Science and Technology, 73, 140-146.

Brandwein, M., Al-Quntar, A., Goldberg, H., Mosheyev, G., Goffer, M., Marin-Iniesta, F., López-Gómez, A. and Steinberg, D. 2016. "Mitigation of biofilm formation on corrugated cardboard fresh produce packaging surfaces using a novel thiazolidinedione derivative integrated in acrylic emulsion polymers". Frontiers in Microbiology. Section Food Microbiology, 7:159 (Doi: 10.3389/fmicb.2016.00159); Open Access.

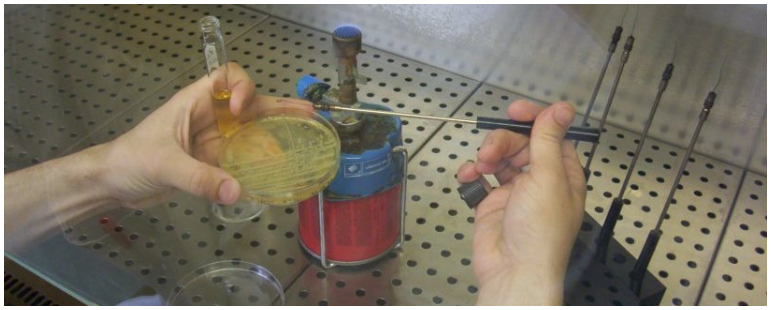
3. Others

Contract: Research and experimental development of new healthier food and advanced packaging (AVANZA – S. Funded by CDTI - Proyecto Estratégico CIEN 2015 (*IDI-20150100*). Participants: UPCT and ELPOZO ALIMENTACIÓN S.A. Company (Alhama, Murcia); from 01/09/2015 to 30/11/2017; UPCT Contract: 48.000 €. Project Manager: López Gómez, A.

Contract: New biotechnological processes of interest for the liquid sugar industry". Funded by CDTI – R&D Project 2014 (*IDI-20141129*). Participants: UPCT and ZUKAN S.L. Company (Molina de Segura, Murcia); from 15/05/2014 to 14/05/2016; UPCT Contract: 105.500 €. Project Manager: López Gómez, A.

Staff: Antonio López Gómez, Asunción Iguaz Gainza, Sonia Soto Jover, María Ros Chumillas, Domingo Miranzo Navarro, Javier Maté Sánchez de Val, M. José Sánchez; Laura Navarro, Laura Buendía

MICROBIOLOGY AND FOOD SAFETY



Description of main results for the Unit this year

The Unit received financial support during 2016 from two research projects, both of them from the Spanish Government, and from one contract with a food company. Four articles were published in indexed journals. One thesis was also defended in this period.

1. Projects

Validation of mild heat preservation processes of foods: establishing microbial food safety. MINECO (ref. AGL 2013/48993-C2-1-R). 2014-2018. Principal investigator: Fernández, P., Principal co-investigator: Palop, A.

Sterilisation of food and animal waste by means of microwave energy with uniform heating technology. MINECO (ref DPI2014-61857 EXP). 2015-2017. Principal investigator: Díaz Morcillo, A.

2. Papers

Maté, J., Periago, P.M. and Palop, A. 2016. When nanoemulsified, *D*-limonene reduces *Listeria monocytogenes* heat resistance about one hundred times. Food Control, 59: 824-828.

Maté, J., Periago, P.M. and Palop, A. 2016. Combined effect of a nanoemulsion of *D*-limonene and nisin on *Listeria monocytogenes* growth and viability in culture media and foods. Food Sci. Technol. Int., 22: 146-152.

Huertas, J.P., Aznar, A., Esnoz, A., Fernández, P.S., Iguaz, A., Periago, P. and Palop, A. 2016. High heating rates affect greatly the inactivation rate of *Escherichia coli*. Frontiers Microbiol., 7: 1256.

Cattani, F., Dolan, K.D., Oliveira, S.D., Mishra, D.K., Ferreira, C.A.S., Periago, P., Aznar, A., Fernández, P., Valdramidis, V.P. 2016. One-step global parameter estimation of kinetic inactivation parameters for *Bacillus sporothermodurans* spores under static and dynamic thermal processes. Food Res. Int., 89: 614-619.

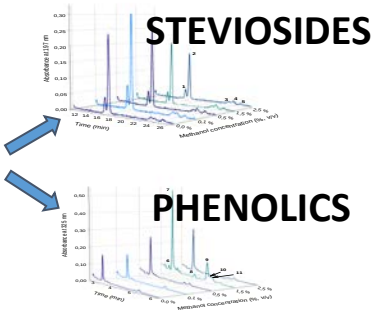
3. Others

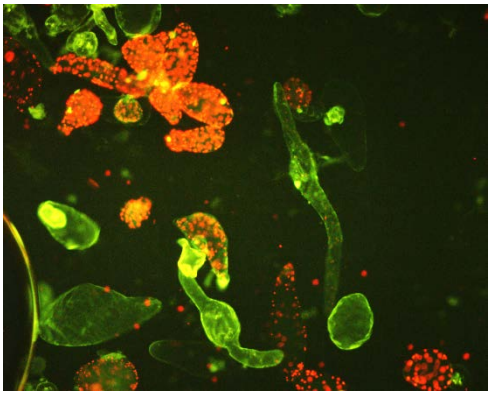
Ph. D. Dissertation: Effect of *D*-limonene in form of nanoemulsion on the viability of *Listeria monoctytogenes* in foods. Author: Javier Maté. Supervisors: Alfredo Palop and Paula M. Periago. Date: 22/04/2016

Contract: Reference: 4419/16IAEA. Company: Marín Giménez S.A. Contract leader: Alfredo Palop

Staff: Alfredo Palop, Pablo S. Fernández, Paula M. Periago. PhD and Máster students: Javier Maté, Alberto Garre, Gerardo González, J. Antonio Sotomayor, Isabel Gómez, Mariem Sormrani, Johanna de Jesús Sarante

SECONDARY METABOLITES





Description of main results

New data were acquired on the involvement of secondary metabolites in plant responses to stress. Compounds with notable antioxidant capacity are differentially accumulated in tissues as a function of the level of stress supported by plants. Analyses of both types and contents of stress metabolites make it possible to discriminate between species populations in a relatively small area by relating metabolite profiles to soil properties. This knowledge could be applied on several different fields, from phytomanagement of polluted areas to production of high added-value metabolites in controlled conditions.

1. Projects

Functional analysis of antioxidant and redox systems in the abiotic stress tolerance of cultivated plants: new perspectives for their agronomical applications and their potential human health benefits. Fundación Séneca (19876/GERM/15). 2016-2020. Project manager: Sevilla Valenzuela. F. (CSIC)

Fitomanejo de residuos mineros en entornos semiáridos empleando biochar y especies arbóreas autóctonas: aspectos ecotoxicológicos y ecofisiológicos. MINECO (CGL2014-54029-R). 2015-2018. Principal investigator: Conesa, H.M.

Uso de composts supresivos y sus extractos biológicos en la producción sostenible y de calidad de rúcula y lechuga baby-leaf en suelo y en bandeja. MINECO (AGL2014-52732-C2-2). 2015–2017. Principal investigator: Fernández, J.A.

2. Papers

Álvarez-Robles, M.J., López-Orenes, A., Ferrer, M.A., Calderón, A.A. 2016. Methanol elicits the accumulation of bioactive steviol glycosides and phenolics in *Stevia rebaudiana* shoot cultures. Industrial Crops and Products 87: 273-276.

Párraga-Aguado, I., González-Alcaraz, M.N., López-Orenes, A., Ferrer, M.A., Conesa, H.M. 2016. Evaluation of the environmental plasticity in the xerohalophyte *Zygophyllum fabago* L. for the phytomanagement of mine tailings in semiarid areas. Chemosphere 161: 259-265.

Ataide, L.M.S., Pappas, M.L., Schimmel, B.C.J., Lopez-Orenes, A., Alba, J.M., Duarte, M.V.A., Pallini, A., Schuurink, R.C., Kant, M.R. 2016. Induced plant-defenses suppress herbivore reproduction but also constrain predation of their offspring. Plant Science 252: 300-310.

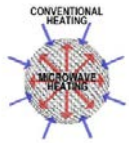
3. Others

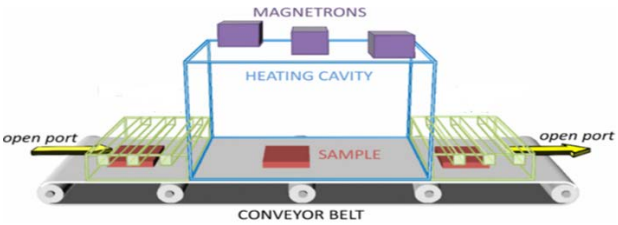
Research stay at University of Amsterdam. From March to June. Researcher: Antonio López Orenes

Research stay at University Campus Bio-medico di Roma. From January to April. Researcher: M. Ángeles Ferrer

Staff: Antonio A. Calderón, M. Ángeles Ferrer, Antonio López Orenes, Matías López Serrano

FOOD QUALITY AND HEALTH





Description of main results for the Unit this year

New data on different fields, for example, in the use of new emerging technologies or in the development of new and functional products as vegetal smoothies or juices. Some results are:

- The use of a continuous microwave, high power/short time, provided the best quality in vegetables smoothies.
- The identification in walnut and almonds, of physiological markers of oxidative stress called phytoprostanes.
- Fashion watermelon juice enriched in L-citrulline diminished muscle soreness perception after a half marathon race.
- UV-C and hyperoxia abiotic stresses can improve healthiness of some vegetables.
- The use moderate high pressure homogenization treatments for functional food supplements, in particular when they are rich in thermolabile bioactive compounds.

1. Projects

Innovative processing of natural refrigerated fresh vegetables smoothies improving its healthiness. MINECO. Principal investigator: Artés-Hernández, F.

In vivo study, in athletes of half marathon, of the intake of watermelon juice to know its potentiality as functional drink. Principal investigator: Aguayo, E.

Comprehensive use of the carob pod in the elaboration of functional foods. Principal investigator: Martínez, A.

2. Papers

Arjmandi, M., Otón, M., Artés, F., Artés-Hernández, F., Gómez, P.A., Aguayo, E. 2016. Microwave flow and conventional heating effects on the physicochemical properties, bioactive compounds and enzymatic activity of tomato puree. J. Sci. Food Agric. 97(3): 984-990. doi: 10.1002/jsfa.7824.

Carrasco-Del Amor, A.M., Aguayo, E., Collado-González, J., Guy, A., et al. 2016. Impact of packaging atmosphere, storage and processing conditions on the generation of phytoprostanes as quality processing compounds in almond kernels. Food Chem. 211, 869–875. Doi: 10.1016/j.foodchem.2016.05.132

Chaparro-Torres, L.A., Bueso, M.C., Fernández-Trujillo, J.P. 2016. Aroma volatiles at harvest obtained by HSSPME/GC-MS and INDEX/MS-E-nose fingerprint discriminate climacteric behavior in melon fruit. J. Sci.Food Agric. 96: 2352-2365. http://onlinelibrary.wiley.com/doi/10.1002/jsfa.7350/pdf

Formica-Oliveira A.C., Martínez-Hernández G.B., Aguayo E., Gómez P.A., Artés F., Artés-Hernández F. 2016. UV-C and hyperoxia abiotic stresses to improve healthiness of carrots. J. Food Sci. Tech. 53(9), 3465-3476. DOI: 10.1007/s13197-016-2321-x.

3. Others

- Ph.D. Dissertation: High homogenization pressures in nutraceutical products with high functional value.
- Ph.D. Dissertation: Effects of continuous microwaving on the overall quality of tomato-based smoothies.
- Ph.D. Dissertation: Identification and quantification of phytoprostanes in nuts as markers of oxidative stress.

Staff: Encarna Aguayo, Francisco Artés Calero, Francisco Artés-Hernández, Juan P. Fernández-Trujillo, Ginés B. Martínez-Hernández, Ascensión Martínez-Sánchez, Noelia Castillejo, Elena Collado, Bárbara Fernández Lobato, Tâmmila Venzke Klug.

MOLECULAR GENETIC

Description of research interest and main results

The way genetic programs and environmental factors such as light and temperature affect plant development are studied. Organ growth and secondary metabolites, specifically volatiles are also analyzed. A system based on machine learning (ML) algorithms and computer vision for automatic phenotype data analysis has been developed. New progress in understanding the common coordination of organ growth and secondary metabolism have been obtained.

1. Projects

Determinación del control de la emisión de volátiles florales por el bucle nocturno del reloj circadiano en Petunia. Seneca 19398/PI/14. 2015-2017. Project manager: Marcos Egea Gutiérrez-Cortines.

Control genético y fisiológico sobre el desarrollo del pétalo y la síntesis de volátiles florales. BFU2013-45148-R. 2015-2016. Principal investigator: Marcos Egea Gutiérrez-Cortines & Julia Weiss.

2. Papers

Weiss, J., Mühleman, J.K., Ruiz-Hernández, V., Dudareva, N. and Egea-Cortines, M. 2016. Phenotypic space and variation of floral scent profiles during late flower development in *Antirrhinum.* Frontiers in Plant Science, 12, doi: 10.2289/fpls.2016.01903.

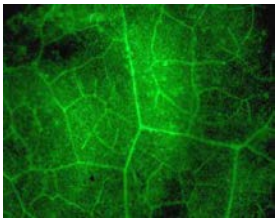
Bombarely, A.,-14 more authors-, Egea-Cortines, M., -35 more authors-, Weiss, J.,-4 more authors-, Kuhlemeier, C. 2016. Insight into the evolution of the *Solanaceae* from the parental genomes of *Petunia hybrid.* 57 authors. Nature Plants, 2(6): 16074. doi: 10.1038/nplants.2016.74.

Navarro, P., Pérez, F., Weiss, J. and Egea-Cortines, M. 2016. Machine learning and computer vision system for phenotype data acquisition and analysis in plants. Sensors 16(5): 641, doi:10.3390/s16050641.

Weiss, J., Alcantud-Rodriguez, R., Toksöz, T., Egea-Cortines, M. 2016. Meristem maintenance, auxin, jasmonic and abscisic acid pathways as a mechanism for phenotypic plasticity in *Antirrhinum majus.* Scienctific Reports 6,19807 doi:10.1038/srep19807

Staff: Marcos Egea Gutiérrez-Cortines, Julia Weiss, Victoria Ruiz-Hernández, Raquel Alcantud-Rodríguez, Claudio Brandoli, Fernando Pérez, Marina Martos-Fuentes, Marta I. Terry

RESISTANCE TO INSECTICIDES



GFP expression in *Nicotiana bethamiana* leaf with a ToLCNDV replicon.

Description of main results

The resistance to pesticides of *Myzus persicae* was studied. Several populations were collected from the main Spanish peach production areas. Those populations were resistant to carbamates (pirimicarb) and pyrethroids (lambda-cyhalothrin), and susceptible to the rest of the insecticides, except some populations that were highly resistant to neonicotinoids.

Biotechnological tools based on Tomato Leaf Curl New Delhi Virus (ToLCNDV) have been developed. Last year, an infectious clone of ToLCNDV was designed and validated and later, a replicon based on the virus sequence was designed. This replicon may allow high expression of heterologous proteins in *Solanaceae* and *Cucurbitaceae*.

The UV-C dose for inducing postharvest lemon's defence against *Penicillium digitatum* was optimized. New plant –pathogen interactions in crops and in postharvest were described for *Rhizopus sexualis* in pumpkins, *Aspergillus carbonarius* in persimmons, *Elsinoë australis* in pomegranates, and *Stemphylium vesicarium* in spinach

1. Projects

Uso sostenible de insecticidas en *Myzus persicae*: diseño de una estrategia de manejo de la resistencia. AGL2014-55298-R. MINECO. 2015-2017. 110.000 €. Principal investigator: Bielza, P.

Resistencia a insecticidas en *Myzus persicae*: mecanismos implicados y estrategias de manejo. 19282/PI/14. Fundación Séneca. 2015-2018. 25.740 €. Principal investigator: Bielza, P.

Estudio de sistemas innovadores de reducción de podredumbres. Mejora de la calidad e identificación de patologías poscosecha. SAT 9821 GRUPO CFM. 2016 – 2017. Principal investigator: Martínez, J.A.

Desarrollo de herramientas biotecnológicas basadas en el virus emergente Tomato leaf curl New Delhi virus. Fundación Séneca. 1925/PI/2014. Participants: IBV-UPCT, CEBAS-CSIC, AbioPep S.L. 2015-2018. 66.000 €. Principal investigator: Petri, C.

Identificación e aislados de *Alternaria sp*. causantes del corazón negro de frutos de granado y estudio de sus implicaciones parasitarias sobre diversas variedades de granado. Viveros Caliplant, Murcia. 2016 – 2017. Principal investigator: Martínez López, J.A.

Nueva ruta biosintética de Ácido Salicílico en *Prunus*, diseccionando las respuestas de defensa de *Prunus* (DefenSA). MINECO AGL2014-52563-R. Participants: CEBAS-CSIC, IBV-UPCT. 2015-2017. 80.000 €. Principal investigator: Díaz Vivancos, P.

2. Papers

Bielza, P. 2016. Insecticide resistance in natural enemies. Advances in insect control and resistance management. Horowitz, A.R. and Ishaaya, I. (Eds). ISBN: 978-3-319-31798-4. 313-329. Springer, Switzerland

Berger, M., Puinean, A.M., Bielza, P., Field, L., Hughes, D., Mellor, I., Hassani, K., Pak, M., Villiamson, M. and Bass, C. 2016. Insecticide resistance mediated by an exon skipping event. Molecular Ecology, 25: 5692-5704.

3. Others

Martínez, J.A. is a new member of working research group GECQRF-SEF – Control Químico de Enfermedades y Desarrollo de Resistencias a Productos Fitosanitarios, belonging to SEF - Sociedad Española de Fitopatología.

The collection of microorganisms of Agriculture, postharvest and sustainability (MAPYS) of Universidad Politécnica de Cartagena is now associated to REDESMI – Red Española de Microorganismos (www.redesmi.es).

Staff: Pablo Bielza, Josefina Contreras, Dina Cifuentes, Juan A. Martínez López, César Petri, Carolina Grávalos, María A. Parra, Lidia Martín, Ana Belando, Virginia Balanza, María Martínez, José E. Mendoza, Inmaculada Moreno

GENETIC RESOURCES

Description of main results for the Unit this year

During 2016, the Genetic Resources Unit have continued working on the conservation, characterization and evaluation of genetic resources, mainly in the framework of the two existing Projects, one financed by the European Commission and the other one by the Ministerio de Economía y Competitividad of the Spanish government. In the same way, the staff of the Genetic Resources Unit have carried out the annual recollection of indigenous wild plant material and their conservation in the Germplasm Bank-UPCT.

1. Projects

Enhancing of legumes growing in Europe through sustainable cropping for protein supply for food and feed. European Comission (FP7-BBBE.2013.1.2-02). Participants: Universidad de Tras Os Montes, Universidad de Agricultura de Atenas, Universidad Politécnica de Cartagena and 9 more. 2014-2018. Project manager: Eduardo Rosa. J.A. Fernández at UPCT. 5.719.442 € (654.624 for UPCT €).

Uso de composts supresivisos y sus extractos biológicos en la producción sostenible y de calidad de rucola y lechuga baby-leaf en suelo y en bandeja. Ministerio de Economía y Competitividad (AGL2014-52732-C2-2). Participants: UPCT and CEBAS-CSIC. 2015-2017. Principal investigator: J.A. Pascual Valero, J.A. Fernández at UPCT. 72.000 €.

2. Papers

Pignata, G., Niñirola, D., Casale, M., Lo Turco, P., Egea-Gilabert, C., Fernández, J.A. and Nicola, S. 2016. Inherent quality and safety of watercress grown in a floating system using *Bacillus subtilis.* The Horticulture Journal 85: 148-153.

Fernández, J.A., Niñirola, D., Ocho, J., Orsini, F., Pennisi, G., Gianquinto, G., and Egea-Gilabert, C. 2016. Root adaptation and ion selectivity affects the nutritional value of salt-stressed hydroponically grown baby-leaf *Nasturtium officinale* and *Lactuca sativa.* AGRICULTURAL AND FOOD SCIENCE 25: 230-239.

Staff: Sebastián Bañón Arias, Encarnación Conesa Gallego, Catalina Egea Gilabert, Juan Esteva Pascual, José A. Franco Leemhuis, Juan A. Fernández Hernández, Juan J. Martínez Sánchez, María José Vicente Colomer, Virginia Sánchez Navarro, Almudena Giménez, Eulalia Martínez Díaz, Marina Martos Fuentes

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