

Advances in the microbiology of table olives: a scientific meeting

 E. Parente^{a,✉},  F.N. Arroyo-López^b and  E.Z. Panagou^c

^aDipartimento di Scienze Agrarie, Forestali, Alimentari ed Ambientali, Università degli Studi della Basilicata, Potenza, Italy

^bDepartamento de Biotecnología de Alimentos. Instituto de la Grasa (CSIC). Carretera Utrera Km 1. Campus Universitario Pablo de Olavide. Building 46. 41013, Seville, Spain

^cLaboratory of Microbiology and Biotechnology of Foods, Department of Food Science and Human Nutrition, School of Food and Nutritional Sciences, Agricultural University of Athens, Iera Odos 75, Athens, Greece, GR-11855

✉Corresponding author: eugenio.parente@unibas.it

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SUMMARY: The scientific meeting “Advances in the Microbiology of Table Olives”, held in Matera (Italy) in September 2025, was the first dedicated forum to bring together researchers and stakeholders in the industry to address current knowledge and future priorities in table olive fermentation. The conference highlighted the central role of microbiology in determining product quality, safety, and functional potential, with sessions covering the impacts of climate change, microbial diversity, -omics approaches, flavor development, starter cultures, spoilage control, reduced-salt processes, and innovative packaging. Participants emphasized the need for standardized methods, data sharing, metagenomic databases, biobanks, and stronger research networks. Applied priorities included functional and probiotic olives, novel starter cultures, improved monitoring systems, and strategies to prevent spoilage while ensuring safety in low-sodium and brine-free products. The meeting fostered collaboration and established a strategic framework to guide interdisciplinary and translational research in the table olive sector.

KEY-WORDS: *Fermentation microbiology; Metagenomics; Reduced-salt processing; Spoilage control; Starter cultures; Table olives.*

RESUMEN: *Avances en la microbiología de las aceitunas de mesa: reunión científica.* El congreso científico “Advances in the Microbiology of Table Olives”, se celebró en Matera (Italia) en septiembre de 2025, siendo el primer encuentro en el que tanto investigadores como industriales discutieron sobre el conocimiento actual y las futuras prioridades de investigación en la elaboración de la aceituna de mesa. El congreso se centró principalmente en aspectos relacionados con la calidad, seguridad y aspectos funcionales de la microbiología de la aceituna de mesa, con sesiones que cubrían los impactos del cambio climático, diversidad microbiana, análisis ómicos, desarrollo de cultivos iniciadores y aromas, control de alteraciones, procesos bajos en sal e innovaciones en el envasado. Los participantes enfatizaron sobre las necesidades de llevar a cabo la creación de redes para compartir información sobre métodos estandarizados de trabajo, datos ómicos y creación de biobancos microbianos. Esta reunión fomentó la colaboración y estableció un marco estratégico para guiar la investigación interdisciplinar y traslacional en el sector de la aceituna de mesa.

PALABRAS CLAVE: *Aceitunas de mesa; Control de alteraciones; Cultivos iniciadores; Metagenómica; Microbiología de la Fermentación; Procesos con sal reducida.*

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1. THE RATIONALE FOR A SCIENTIFIC MEETING ON TABLE OLIVE MICROBIOLOGY

Fermentation is crucial to transforming olive fruit into an edible food. Microorganisms are a critical element in table olive fermentations, and influence the quality and safety of the final product (Arroyo-López *et al.*, 2012a). Thereby, the microbiology of table olives has traditionally been studied by a small but active community of scientists mainly located in Southern Europe. A composite search on Scopus with keywords [ABS (table olives) AND (ABS (microbiology) OR ABS (microbiota) OR ABS (spoilage) OR ABS (yeasts) OR ABS (spoilage) OR ABS (fermentation))] performed at the time of writing of this document (February 2026), returned 505 scientific papers in peer-reviewed journals, thus showing that this is an actively developing field.

Recent scientific meetings (FoodMicro 2024 in Burgos, Spain; Microbial Diversity 2025 in Rome; the 1st International Conference on Fermented Foods in 2025 in Bozen, Italy) have featured both oral communications and poster presentations addressing table olive microbiology. However, a dedicated forum in which scientists and the table olive industry concurred to present and discuss the latest advances in this field was lacking.

Thus, a small but specialized conference on “*Advances in the microbiology of table olives*” was organized with the objectives of: i) showcasing the most recent advances in the field; ii) discussing future needs for research; iii) promoting the exchange of knowledge and resources; iv) promoting collaboration between scientists and stakeholders.

The conference was funded by the METAolive project coordinated by Prof. Eugenio Parente and was held under the patronage of the Società Italiana di Microbiologia Agroalimentare ed ambientale, the Dipartimento di Agraria, Università degli Studi di Napoli “Federico II”, the Agricultural University of Athens, Greece, and the International Olive Council, Madrid, Spain, and took place in Matera, Italy, on 1-2 September 2025, as a hybrid conference with attendance both in person and remotely.

The meeting was organized in five scientific sessions which included: S1 - Facing the challenges of climate change (invited talks); S2 - Table olives: diversity and microbiology (invited talks); S3 - Microbiome, flavor, aroma, functionality of table olives (invited talks); S4-S5 - Advances in research on table olives (contributed talks); Concluding remarks. A (virtual) poster session was also available. Details can be found in the meeting web page: https://web.unibas.it/parente/?page_id=2088

Thirty researchers participated in person and 40 attended the virtual session, with representatives from 9 countries, 22 universities and research centers, and 12 companies or producer associations (Figure 1).

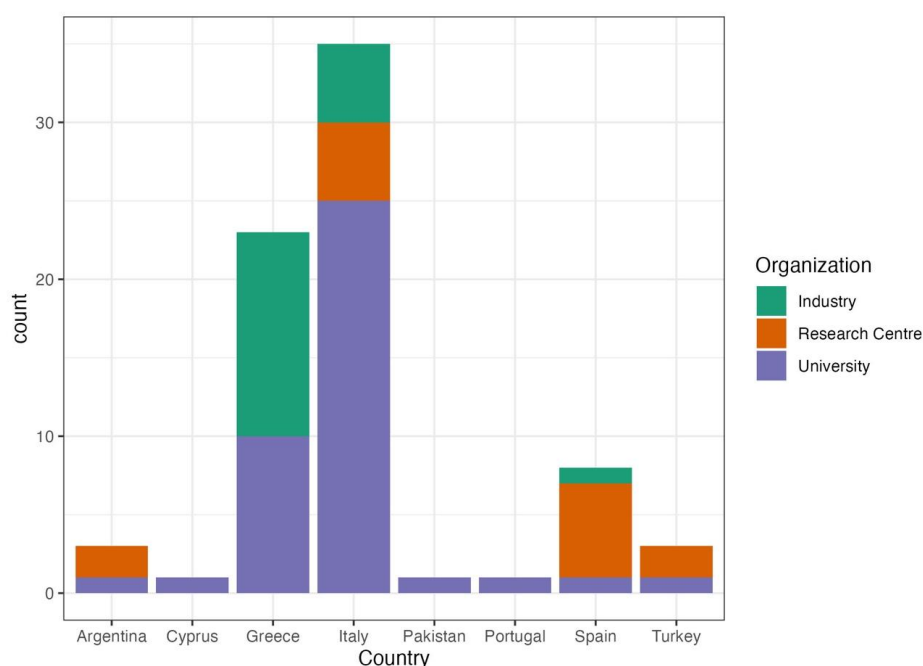


Figure 1. Counts of the number of participants to the meeting by country of origin and organization type.

The sessions covered the scientific and technological challenges of climate change for olive cultivation and table olive production, the diversity of table olives produced in Spain, Greece, Argentina, and Italy, the approaches, from traditional, cultivation-based protocols to state of the art methods based on -omics used for the characterization of olive microbiota, the methods used for the study of flavor and odor-active compounds, the development of functional products based on the addition of probiotics, biopreservation and starter cultures, spoilage and methods for monitoring and preventing it, packaging and the extension of shelf-life. The abstract book is publicly available at: <https://web.unibas.it/parente/?p=2208>.

Beyond the presentations, the event's final round table served as a strategic forum for researchers and industry stakeholders to define future directions for the sector. This review synthesizes those insights, providing a forward-looking perspective on the research priorities and collaborative efforts required to advance the microbiology of table olives in the coming years.

2. THE ROUND TABLE: PARTICIPANT INTERACTIONS/OPINIONS

Interactive tools such as Mentimeter involved the participants in a discussion on future developments and topics deserving further investigation or collaboration. In general, the response of the participants to the conference was positive (Figure 2).



Figure 2. Word cloud for participants' sentiment toward the conference.

A consensus was made that a scientific conference focusing on table olive microbiology, chemistry and technology should be organized at least every two years. However, the increased involvement of stakeholders in the planning and organization stages was identified as necessary to maximize the impact in terms of dissemination. Therefore, the participation of table olive trade associations will be a priority in future editions.

The participants emphasized that applied research on table olives should prioritize the development of functional and probiotic olives, new starter culture systems, low-salt olives, and new preservation processes and methods to detect and control spoilage (Figure 3).

All agreed that more should be done to create scientific collaboration networks, prioritizing the development of standardized methods for microbiological analysis, metataxonomic and metagenomic databases on the composition of microbial communities in olives, on the impact of climate change, and the creation of biobanks with microbial isolates obtained from table olive processing.

Indeed, the open sharing of data, software and biological resources and the creation and strengthening of research networks should be prioritized and we are confident that the conference was a step in this direction (Figure 4).

While the participation of industry representatives to the debate was limited, they vocally expressed the need for better research which is focused on aspects related to spoilage, and process monitoring.

Which of these items do you think applied research should prioritize?

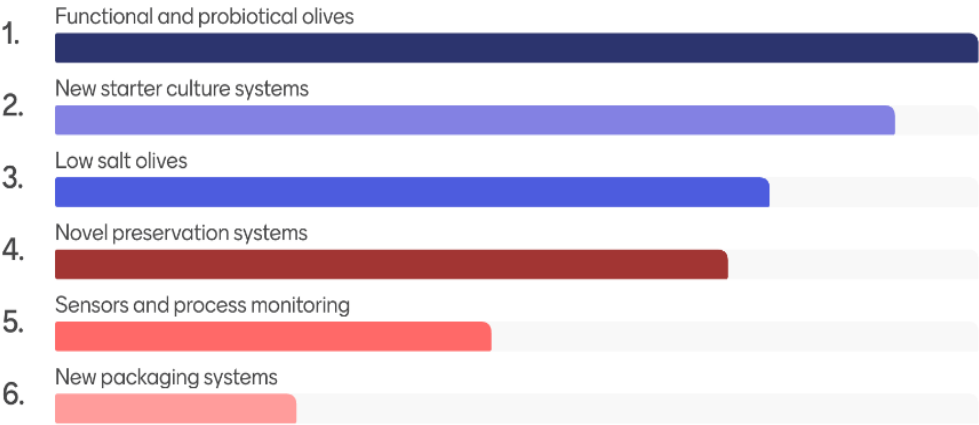


Figure 3. Bar chart showing applied research needs for table olives.

Which do you think are the topics that should be the focus of scientific collaborations?

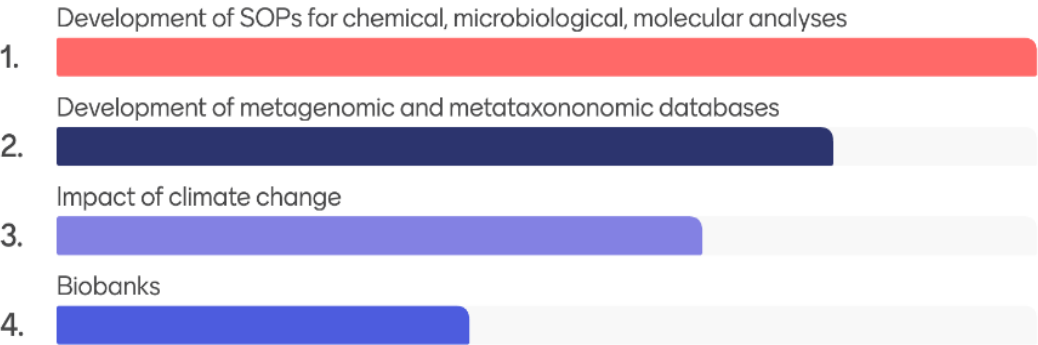


Figure 4. Bar chart showing topics proposed for scientific collaboration.

3. RESEARCH AND COLLABORATION NEEDS IN TABLE OLIVE MICROBIOLOGY

3.1. Data sharing and databases

The advent of -omics approaches has revolutionized the study of the microbiology of fermented foods, and metataxonomic and volatilomic studies are becoming standard in the study of table olive microbiology (Tsoungos *et al.*, 2023). Data sharing and standardization were actually the two topics which participants at the meeting identified as priorities in research collaboration.

Metataxonomic and metabolomic data are rapidly accumulating but there still a lack of metagenomic data, and this limits our understanding of the diversity of table olive fermentation below the genus/species level. The curatedFoodMetagenomicData (cFMD) database (<https://github.com/SegataLab/cFMD>) does not yet

include data on table olive metagenomes but we are confident that this will soon be changed by the release of shotgun metagenomic data on table olives (180 samples) collected and processed within the METAolive project.

On the other hand, we recently reviewed metataxonomic studies on table olives (Ricciardi *et al.*, 2025) and created a database of metataxonomic studies with an extended annotation scheme (OliveFMBN, available at <https://dx.doi.org/10.5281/zenodo.13729346>): this resource can be accessed using R scripts and used for metastudies on table olive microbiology or even to develop machine learning applications to identify factors related to identity or quality. We recently added data from a large survey on table olive microbiology (364 samples from 40 producers and 6 countries, Parente *et al.*, 2026) and more data will become available when a new version of FoodMicrobionet becomes available. In fact, a pre-release of FoodMicrobionet version 5.1.2 added 2 more studies on table olives to what was available in version 5 (Parente and Ricciardi, 2024) and is now available as an interactive app (https://ep142.shinyapps.io/ShinyFMBN_4_light/) whose use requires no coding experience. Increased collaboration among research groups and the integration of further metadata (salt, pH, microbial counts, etc.) may greatly enhance our ability to mine data on the microbiology of table olives.

3.2. Beneficial microorganisms

As previously mentioned, starter cultures and probiotics were among the most relevant topics prioritized by participants for further table olive research. Numerous studies have demonstrated the enormous potential that both lactic acid bacteria (LAB) and yeast starters could have in the elaboration of this fermented food from both technological and probiotic perspectives (Anagnostopoulos and Tsaltas 2022; Arroyo-López *et al.*, 2012a; Bevilacqua *et al.*, 2012; Bonatsou *et al.*, 2017; Erdemir Tiras and Kalkam Yildirim, 2021; Garrido-Fernández *et al.*, 2021; Portilha-Cunha *et al.*, 2020). Applying starter cultures of both types of microorganisms (pure cultures or microbiome-based), mainly LAB for lye NaOH-treated olives or yeast for natural presentations, could notably improve the fermentation of table olives, mainly by: i) shortening the process due to a rapid decrease of the bitter oleuropein through hydrolysis mediated by microbial enzymatic activity; ii) standardization of products; iii) rapid acidification of the medium; iv) better organoleptic profile; and v) depletion of sugars and consequently product stabilization.

In addition, the capacity of LAB and yeasts to adhere to the surface of olives and the formation of biofilms during fermentation, combined with the production of exopolysaccharides, establish new perspectives for utilizing table olives as a functional food with high added value (Arroyo-López *et al.*, 2012b). Thereby, multifunctional cultures with probiotic properties isolated from table olives may serve as food-fortifying agents or as multifunctional starters or adjunct cultures in the fermentation of table olives (Argyri and Tassou, 2022). López-García *et al.* (2023) recently conducted the only clinical trial with humans to prove the probiotic features of *Lactiplantibacillus pentosus* LPG1, a natural strain isolated from table olive fermentations. They found that oral daily intake (10^9 CFU) of *L. pentosus* LPG1 for 30 days improved the regulation of gut microbiota. Previously, Benítez-Cabello *et al.* (2020) also proved the anti-inflammatory and immunomodulatory properties of this strain in an induced chronic colitis murine model. Thus, the search for microorganisms isolated from table olive fermentations with these characteristics is an area of research of interest. The sharing of genomic and phenotypic data among researches, with the creation of culture collections defining Nagoya protocol to guarantee the exchange of bioresources is identified as useful to facilitate progress. Similarly, the preservation and creation of biobanks of whole microbiomes would be appropriate to capture a large part of the biodiversity of table olive processing (Gialluisi *et al.*, 2026).

3.3. Industrial perspectives

Despite significant advances in the scientific knowledge on fermented foods, table olive fermentation largely remains a craft-based and empirical process, strongly shaped by local traditions and practices. Although the benefits of employing starter cultures have been extensively documented (Bonatsou *et al.*, 2017), their use by the table olive industry remains limited. Today, table olive fermentation occurs spontaneously due to

the autochthonous microbiota associated with the olive fruit and the processing environment. Under these conditions, deviations from the desired fermentation may occur, primarily due to the growth of undesirable microorganisms, leading to the production of metabolites that may cause abnormal fermentation and result in a defective final product. Thus, the spoilage of table olives represents a major challenge for the table olive industry, resulting in substantial economic losses. Frequently encountered spoilage phenomena include: the formation of “gas pockets” due to the metabolic activity of Gram negative bacteria or *Celerinatantimonas*, resulting in softening and cuticle rupture; the development of an unpleasant smell associated with the decomposition of organic matter (putrid fermentation) caused by *Clostridium* spp.; the characteristic smell of rancid butter (butyric fermentation) caused by butyric anaerobes such as *Clostridium butyricum*; olive softening associated with the growth of pectinolytic and cellulolytic yeasts and fungi; and the defect known as zapateria, characterized by a smell reminiscent of rotten leather, which is linked to the activity of *Propionibacterium* spp. and *Clostridium* spp. (Lanza, 2013). Effective control of spoilage requires an understanding of the microbial ecosystem driving fermentation, together with improved monitoring of critical process parameters. This aspect was defined by the participants of the conference held in Matera as a key priority area for targeted scientific collaboration (Figure 4). In this context, industry representatives emphasized the need for enhanced research efforts focused on spoilage control and process monitoring.

Another major challenge for the table olive industry today is the use of high salt concentrations during table olive fermentation, which is against modern dietary recommendations that demand reduced sodium intake in the diet. This issue was also identified by the conference participants as the third most important priority for applied research (Figure 3), reflecting the well-established association between sodium intake and cardiovascular diseases (Li *et al.*, 2026). The perspectives for reduced-salt products, including table olives, is rather promising, as the global reduced-sodium food products market was valued at US\$ 315.6 billion in 2021 and is expected to expand at a compound annual growth rate (CAGR) of 5.1% over the period from 2022 to 2030, due to customer desire for a healthy lifestyle (GVR, 2020). Therefore, sodium reduction will establish additional health-promoting features in table olives, and also, provide an opportunity to increase the market share for reduced-sodium table olives. However, special attention is required as sodium reduction may adversely affect the microbiological stability and safety of the final product. To counterbalance this potential risk, the application of starter cultures with targeted functional properties becomes essential, enabling the transformation of table olives from a conventional agricultural commodity to a high-added-value functional food.

As mentioned before, the management of the fermentation process remains largely empirical, relying primarily on fixed processing times and operator experience rather than on continuous monitoring of critical parameters. Consequently, conventional monitoring practices, which depend on labor-intensive and time-consuming analytical methods, provide a limited temporal resolution which is necessary for proactive process control and restricts the timely implementation of corrective interventions during fermentation (Schorn-García *et al.*, 2026). These limitations may be effectively addressed through the integration of sensors enabling on-line, in-line, and at-line monitoring of critical process parameters (e.g., pH, salt content, acidity) within the concept of Process Analytical Technologies (PAT) (Kazou *et al.*, 2025). This need was also identified as a priority for applied research by the conference (Figure 3), although it did not rank among the highest priority topics.

Another key priority for applied research derived from the conference concerned the development of novel preservation and new packaging systems (Figure 3). Following fermentation, table olives are packaged in glass or plastic containers, tins, and plastic (single- or more frequently multi-laminated) or aluminum pouches, in order to enhance their commercial value and facilitate market expansion. These packages are typically filled with brine, which may contain additives to improve the microbiological stability and preserve sensory attributes. In parallel, alternative preservation and packaging approaches are gaining increasing attention, including modified atmosphere packaging, vacuum packaging, active packaging, and the use of edible coatings and films, the latter having long been used to extend the shelf life of fresh fruit and vegetables (Campus *et al.*, 2018). In the case of table olives, there is an increasing trend toward brine-free packaging in pouches, aiming to provide convenient, lightweight, and easy-to-use snack packs. However, the commercialization of table olives in pouches may introduce new safety challenges, as the absence

of brine may compromise the effectiveness of combined hurdles of low pH, salt concentration, and the presence of antimicrobial metabolites in the covering brine, thereby potentially affecting product stability and microbiological safety. This demands coordinated research through international cooperation to advance sustainable and microbiologically safe packaging strategies.

4. CONCLUSIONS

The celebration of this congress has provided an opportunity for collaboration between industry and researchers on diverse relevant topics that will guide research on the microbiology of table olives in the coming years. At the same time, a connection has been established among the different participants for the celebration of future editions. For the first time, the congress provided a forum that brought together the industry and academia to discuss current knowledge, identify critical gaps, and define strategic priorities for future research and innovation in the table olive sector. The width of contributions underlined the central role of microbiology in defining the quality, safety and functional potential of table olives and highlighted the need for interdisciplinary and translational research efforts.

RESEARCH DATA POLICY

DATA AVAILABILITY

The OliveFMBN dataset, storing metataxonomic data on table olive microbiology, together with extended metadata is available from Zenodo: <https://dx.doi.org/10.5281/zenodo.13729346>

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DECLARATION OF COMPETING INTEREST

The authors of this article declare that they have no financial, professional or personal conflicts of interest that could have inappropriately influenced this work.

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AUTHORSHIP CONTRIBUTION STATEMENT

E. Parente 01: Funding acquisition, Project administration, Writing – original draft, Writing – review & editing. F. N. Arroyo-López: Writing – original draft, Writing – review & editing. E.Z. Panagou: Writing – original draft, Writing – review & editing.

Artificial Intelligence Usage

AI was not used in writing or editing this contribution.

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