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Editorial

Editorial 14th international symposium on lactic acid bacteria (LAB14)

This thematic issue of FEMS Microbiology Reviews covers the highlights of the 14th International Symposium on Lactic Acid bacteria (LAB14), which will be held from 27th to 31st of August 2023 in Egmond aan Zee, the Netherlands. The first edition of this successful series of triennial symposia was organized in 1983, in Wageningen, the Netherlands. Even after 40 years, this symposium series still offers established and more importantly, early stage researchers in the field of lactic acid bacteria (LAB) from all over the world, the opportunity to present progress reports to the experts and a platform for scientific interactions. During the last edition of the LAB series, also the LAB community experienced the consequences of the COVID-19 pandemic. The previous edition took place as an online symposium and this meeting was, given the circumstances, definitely successful in reaching the scientific community. However, personal interactions through an online platform are less effective compared to real life meetings, and therefore, the organizing committee is delighted to welcome the LAB scientific community at a face-to-face/physical meeting.

The scientific program includes: invited plenary lectures providing overviews of state-of-the-art developments in selected scientific areas, short plenary lectures that cover the most recent advances in LAB research and application, and several plenary poster sessions. To broaden the perspective of the LAB researchers, also this time speakers were invited from adjacent fields in microbiology. This edition covers a variety of research themes: (i) microbial communities, (ii) genetics and genomics, (iii) fermentation and metabolism, including the role of LABs in the fermentation of plant based proteins, (iv) host–microbe interactions, and (v) bacteriophages and antimicrobials.

The following description of the contributions to this special issue of FEMS Microbiology Reviews, illustrates the broad spectrum of topics that will be presented and discussed during the symposium. Turner and coworkers (2023) will present an overview of recent studies on cyclic-di-AMP signaling in LAB, all of which possess genes encoding enzymes for the synthesis and degradation of cyclic-di-AMP. Moreover, they show that LAB are highly variable with regards to the cyclic-di-AMP receptors they possess. This research contributes to our mechanistic and molecular understanding of how bacteria and in particular LAB sense their environment and how they respond to it.

Fundamental understanding of the functioning of any microorganism requires insight in (i) the physicochemical properties of the cytoplasm and in (ii) the regulatory mechanisms to govern physicochemical homeostasis. Poolman (2023) delivered a contribution to this special issue of FEMS Microbiology Reviews that describes how intracellular pH and proton motive force are regulated and how internal ionic strength is kept within critical limits. Furthermore, this contribution discusses the impact of macromolecular crowding on the functioning of cytoplasmic enzymes as well as the regulation of cell volume and turgor pressure. Although physicochemical homeostasis is best understood in *Escherichia coli*, some of these fundamental insights are based on pioneering studies performed with LAB as model organisms.

An important reality in the environment of any bacterium is the presence of bacteriophages. Lavelle et al. (2023) present a broad view on the interactions between bacteriophages and their target bacterium *Streptococcus thermophilus*. They describe in detail the implications of these interactions for genetic diversity and evolution of both biological entities. Finally, this view is linked to the consequences for applied research on the development of robust starter culture systems.

Philippe et al. (2023) also critically reviewed the 'never-ending battle between lactic acid bacteria and their phages'. They particularly focus on defense systems that LAB in general employ to resist phage infections and how phages react to these defenses via their own sophisticated strategies, shaping each other's evolution.

In line with the contribution of Holtappels and coworkers (2023), Lavelle et al. (2023) critically explore the drivers of phage infection and host range in a broader context, beyond the field of LAB phage biology. They cover this topic from molecular underpinnings of the phage–host interaction all the way to the ecological context in which these processes occur as well as in the framework of coevolution.

Leroy and coworkers (2023) present an important and state-of-the-art review on the microbiology, nutritional value, perceived concerns, and innovations of fermented meat. They describe, among various other aspects, the challenges faced by the meat industry to combine the production of standardized and safe fermented meat products with the traditional identity of such products, while respecting market constraints and quality criteria.

Nisin, an antimicrobial peptide produced by some strains of *Lactococcus lactis*, was discovered in the same year as penicillin, 1928. Both antimicrobials are still in practical use, although in quite different applications. Nisin is in use as a natural food preservative (Field et al. 2023). The review by Field et al. (2023) describes the knowledge we have obtained during a century of research on nisin biosynthesis and the diversity identified among the natural nisin variants from LAB species. Mode of action and engineering of antimicrobial activity is also covered. The perspectives of using nisin for modulating microbiota and the potential of developing drugs based on nisin indicates a possible direction for the second century of nisin research (Field et al. 2023).

The lantibiotics of which nisin is a prominent member are characterized by extensive post-translational modification (PTM) after the ribosomal synthesis. The review by Fu et al. (2023) describe the large number of PTMs found in lantipeptides and the use of those mechanisms to establish a combinatorial generation of novel peptides with modified or entirely new biological activities.

Another interesting type of antimicrobial activity is linked to free fatty acids (FFAs). Borreby et al. (2023) extensively reviewed

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the anti-infective activities of long-chain fatty acids against foodborne pathogens. They argue that long-chain FFAs potentially disarm virulence factors of bacterial pathogens.

Food fermentations based on LAB are usually conducted without aeration and consequently the overall metabolism requires the sum of all redox reactions to be balanced. LAB species and strains have developed different solutions to this constraint, and some LAB have developed extracellular electron transfer pathways to expand the metabolic capacity. The review of Stevens and Marco (2023) describe the general bacterial occurrence of extracellular electron transport systems including examples from LAB.

We are currently facing a need to transform our food production towards primarily using plant raw materials. For the production of fermented products, this transition necessitates the development of starter cultures with phenotypes different from the traditional cultures, even if the target for the organoleptic properties of the fermented food is to match a traditional product. Fortunately, we will not need centuries of trial and error to identify such cultures. The review by Karlsen et al. (2023) describes how computational methods allow integration of genome sequence data, metabolic modelling, and data in general to predict phenotypes with an accuracy useful for strain selection. Even the performance of microbial communities can be modelled and guide the composition of a mixed starter culture (Karlsen et al. 2023).

As demonstrated by this special issue and by the scientific program of the LAB14 symposium, the international community of researchers in the field of LAB continuously pushes the field further on running topics such as (i) the role of LAB in complex microbial communities, (ii) the impact of LAB on human and animal life, and (iii) the contribution of LAB in food biotechnological applications. In the context of novel food applications, many new research lines are being developed, of which in particular the role of LAB in the production of fermented protein rich plant-based substrates should be mentioned.

***Conflicts of interest*:** None declared.

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