The role of lactic acid bacteria in food fermentation

Last Updated : 16 January 2025

The unique flavours, textures, and health benefits of fermented foods like yogurt, sauerkraut and sourdough bread come from a community of microorganisms that transform regular ingredients into something special. Among the key players in this process are lactic acid bacteria. So, what exactly are lactic acid bacteria, and how do they work?

What are lactic acid bacteria?

Lactic acid is a substance produced during fermentation by a group of bacteria called Lactic Acid Bacteria (LAB). These bacteria break down sugars in foods, such as lactose (found in dairy products) and fructose (found in fruits and some vegetables), producing lactic acid as a result . There are many different strains and species of LAB, and they can naturally be found in plants, foods, and even the digestive systems of humans and animals[2].

LAB are some of the most studied microorganisms[2]. They’re the most common microorganisms involved in food fermentation and have been used for thousands of years to make fermented foods in a process known as lacto-fermentation[3]. While the name "lactic" comes from the Latin word for milk ("lactis"), because lactic acid was first discovered in sour milk, lacto-fermentations are not exclusively dairy related, but occur also in other matrices. Lacto-fermentation occurs during the production of several kinds of foods, like pickles, sauerkraut, kimchi, sourdoughs and even some cured meats. The “lacto” part just refers to the lactic acid produced, which makes these foods a little sour and acts as a natural preservative[1].

Several species of LAB are recognised as safe by food safety authorities around the world. They are considered beneficial bacteria that enhance food safety and quality and have been part of traditional diets for centuries[4].

Are lactic acid bacteria aerobic or anaerobic?

LAB can survive in both oxygen-rich (aerobic) and oxygen-poor (anaerobic) environments. However, only in limited oxygen conditions their metabolism shifts towards fermentation[5].

What are the uses of lactic acid bacteria?

LAB play a major role in the fermentation of many foods. The process of lacto-fermentation transforms ordinary ingredients like milk, wheat, vegetables, and meat, into distinct sour or tangy foods like yogurt, sourdough bread, kimchi, and saucisson. LAB can naturally occur in foods (in the right conditions), or specific strains, called "starter cultures," can be added to achieve particular results[6].

Here's how LAB enhances food:

- **Preservation:** LAB lower the pH of foods, creating an acidic environment that prevents harmful bacteria from growing. This natural preservation method keeps foods fresh longer and extends their shelf-life[5].
- **Flavour and texture:** LAB give fermented foods their signature tangy flavours, like in kimchi or sourdough bread, or smooth and creamy textures, like in yogurt. This is because they produce exopolysaccharides which increase the thickness of the final product.
- **Safety:** some LAB species produce antimicrobial compounds, which discourage the growth of harmful pathogens (microorganisms that can pose a risk for human health).

Beyond food, LAB have applications in agriculture, medicine, cosmetics, and in the production of eco-friendly alternatives to plastics[1, 7].

What foods contain lactic acid/lactic acid bacteria?

Lactic acid is generated in the production of various fermented foods, including[8]:

- **Fermented milk products:** yogurt, cheese, butter, buttermilk, kefir, and kumis.
- **Fermented vegetables & fruits:** firm vegetables like cabbage, cucumber, radish, cucumber, and juicy fruits like mango, berries, apricots, or plums, are often lacto-fermented (all you need is salt, clean jars, and some time!).
- **Fermented cereals & grains**: injera (Ethiopian pancake); sourdough bread; miso paste (with barley) and traditional recipes like dhokla (rice cake from India).
- **Fermented beverages:** kombucha and traditional beverages like boza, pito, or merrisa.
- **Cured meats:** certain sausages (like salami) and cured fish.

The exact amount of LAB eaten via specific fermented foods is highly variable, due to differences in where it comes from, the manufacturing process, storage conditions, and other factors. For this reason, it is still not completely known how exactly LAB interact in our gut. Processing also impacts whether live LAB are directly ingested or not – for example, fermented baked goods such as sourdough bread that is cooked, or fermented vegetables that are pasteurised, no longer contain 'live microbes'. Regardless, fermented foods that don't contain live microbes can still have other health benefits. Microbes can produce beneficial compounds that are then ingested by consumers (such as vitamins), they may remove antinutritional factors and improve digestibility[2].

Are lactic acid bacteria probiotics?

Yes, many LAB are classified as probiotics, but not all of them. Probiotics are living organisms that, when consumed in adequate amounts, can provide health benefits. Probiotics can help balance the gut microbiome, improve digestion, and support the immune system.

Some strains of LAB meet the criteria to be considered probiotics. For example[9]:

- Lactobacillus species: such as *L. acidophilus* found in fermented foods such as yoghurt, kefir, miso, tempeh, and sauerkraut.
- Bifidobacterium species: such as *B. bifidum* also found in fermented foods.
- Streptococcus thermophilus: found in foods such as milk, cheese, and other dairy products.

However, not all LAB can be classified as probiotics because they must meet specific criteria. For example, they must be able to survive the acidic environment in our stomach, be able to adhere to our intestinal cells, and provide measurable health benefits. That is why each strain must be evaluated individually to determine its probiotic properties.

What are the health benefits of lactic acid bacteria?

Depending on the specific food, technology of production, and fermentation process, fermented foods can contain several LAB species and strains, which can positively interact with the gut microbiome1. Scientists have found several connections between LAB and positive impacts on human health, such as[1,4]:

- **Gut health:** LAB can produce vitamins, short-chain fatty acids, and bacteriocins; may discourage harmful bacteria growth; and help balance beneficial gut bacteria.
- **Improved digestibility & nutrient absorption:** LAB can improve digestion and nutrient absorption, particularly of proteins.
- **Allergy reduction:** LAB can reduce the allergenic properties of some foods, such as dairy or wheat, by breaking down specific proteins that cause allergic reactions.
- **Antioxidant properties:** Some LAB strains produce antioxidant compounds that help fight harmful free radicals.
- **Stress relief:** Certain LAB strains produce a compound called GABA, which acts as a neurotransmitter that can lower blood pressure, relax muscles, and reduce psychological stress.

Conclusion

LAB play a key role in food preservation and flavour development and have been a key player in human food production for thousands of years. They are not only of significant economic importance but also contribute to a crucial role in promoting and maintaining human health. LAB are excellent representatives of the often-misunderstood microbial world, where they can be recognised and appreciated for their positive associations in human health and cuisine.

Project highlight: To better understand how microbes interact with our health, the EU-funded DOMINO project is exploring how fermented foods, such as those developed via Lacto-fermentation, could shape the gut microbiome and deliver health benefits. The project will explore both dairy and plant-based fermented foods, and how they modulate the gut microbiome and support the health of people, notably those with metabolic diseases.

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