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Editorial: Fermentation and enzymatic processes for the production of functional food

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Editorial on the Research Topic
Fermentation and enzymatic processes for the production of functional food

The world is facing major challenges due to climate change, emerging infectious diseases, and the negative impact of industrialized diets on health. Since the first civilizations, fermentation and empirical enzymatic technologies have been used to enhance food and nutrition and were an inherent part of the ancient diet. Egyptians mastered the art of brewing (Wang et al., 2021). Fermented milk was valued in the Ancient Near East (Genesis 18:8, King James Bible, 2019). Early Neolithic pottery in China showed evidence of using malts, yeast, and herbs for alcoholic fermentation (Liu et al., 2019). In the past century, the food industry has experienced significant growth thanks to the use of industrialized starters, yeast, and more recently, recombinant enzymes. Nowadays, fermented food is attracting a renewed interest due to the information provided recently by the "omics" technologies, which reveal the various benefits it brings to nutrition and health enhancement, such as cardiovascular, neurological, and immunological functions. Moreover, the use of these technologies applied to food waste has allowed us to obtain valuable by-products and food ingredients with different functionalities, including emulsifiers, biodegradable coating, antimicrobial films, and antioxidants. This Research Topic aimed to highlight the recent advancements in fermentation and enzymatic technologies for creating functional food products and transforming food waste into valuable food products or functional ingredients. This topic collection comprises 1 review, 3 original articles, and 1 perspective article.

The first article reviews the use of date pits to extract bioactive compounds with diverse functionality. The pits of date fruit are often seen as a by-product. However, they contain valuable antioxidant compounds like polyphenols, proteins, oil, minerals, and fiber. Extracting them properly can result in functional ingredients for food products. These include emulsifiers, fat substitutes, the ability to form hydrocolloids and additives for meat and dairy products, caffeine-free hot drinks, and bakeries. Some notable features include its antimicrobial and antioxidant properties and its ability to improve sensory qualities.

The second one is an original article about the characterization of stingless bees' honey (SBH). This is traditionally acknowledged for its therapeutical properties and is an important source of fructo-lactic acid bacteria and bioactive compounds (Pimentel et al., 2022). SBH's

physicochemical properties and antioxidant activity were evaluated and found significant differences between them. Moreover, SBH from four different species were characterized and seven fructolactobacillus bacteria were identified. It is noteworthy that three of the identified isolates are potentially novel strains with probiotic properties and potential biotechnological applications.

Enzymatic processes are a suitable technology for converting food waste into valuable products from the agroindustry. The third paper is an original article that discusses the enzymatic treatment of shrimp residues. These contain a significant amount of chitin, which is primarily composed of N-acetyl-glucosamine. This substance has therapeutic properties against coronary disease and gonarthrosis and is used as a sweetener (Cardozo et al., 2019). Moreover, the use of colloidal chitin facilitates the access of chitinolytic enzymes. The purpose was to optimize the enzymatic hydrolysis of colloidal chitin to substitute chemical hydrolysis yielding up to 2.65% of N-acetyl-glucosamine production. The enzymatic complex employed in this process was obtained from a moderate halophilic marine bacterium isolated from the Mexican Caribbean Sea in the state of Yucatan.

Many traditional fermented foods have not been thoroughly researched, but they could be valuable sources of new microorganisms that may have useful biotechnological applications. With the increasing accessibility of genome sequencing, it is possible to comprehensively analyze the genomes of these fermented foods and the metabolites they produce. In the fourth article, the fermentation microbiota present in traditional date vinegar was characterized. The study identified 35 yeast species belonging to 6 different genera, and 55 species of acetic acid bacteria, including five belonging to Gluconobacter (G). Among these, *G. japonicus* and *G. oxydans* were found to be tolerant to ethanol levels of up to 12.5%, while *G. frateurii* was able to survive at a pH of 2.59. These strains can be utilized to produce either acetic acid or ethanol.

Finally, a perspective paper discussed the use of fermented food that contains targeted probiotics designed to improve mental disorders, such as depression and anxiety, derived from childhood emotional neglect (EN). According to the authors, people with EN often experience chronic inflammation at a lower level. This can increase the risk of health problems such as chronic metabolic disease, as well as cognitive impairment and social anxiety later in life. Interestingly, the intervention of probiotics on the microbiota-gut-brain axis offers a potential solution to these problems by producing neuroactive compounds during fermentation. This intervention can help to modulate the immune system and to reduce inflammation associated with EN in conjunction with cognitive-behavioral therapies that may lead to the improvement of mental health and better social adaptation. Some of these compounds produced by lactic acid bacteria (LAB) during fermentation are gamma amino butyric acid (GABA), which possesses anxiolytic and anti-inflammatory properties (Bhandage et al., 2018), and butyrate which has shown immunomodulation and neuroprotective effects (Koh et al., 2016). While there is an increasing amount of evidence in animal models, there are currently no reports available on the effects of probiotic interventions in EN patients with mental disorders.

In conclusion, the use of controlled fermentation and enzymatic technologies offer great advantages to produce functional food and conversion of food waste, such as being less pollutant compared to chemical conversion, using less energy, and coming from natural sources. Moreover, an increasing number of microorganisms with biotechnological applications have been isolated from traditional spontaneous fermentations. Thanks to more accessible genome sequencing and other "omic" techniques their microbiota and their potential benefits have been characterized. Regional products like stingless bees' honey and traditional vinegar, along with food by-products such as date pits and shrimp shells, offer a considerable amount of bioactive compounds with therapeutic and functional properties. These contribute to a more sustainable food industry.

Author contributions

CG-G: Conceptualization, Writing—original draft. GM-L: Writing—review and editing. DO: Writing—review and editing. NA-H: Writing—review and editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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