FACT SHEET

Traditional Fermentation: an ancestral technology providing new solutions for alternative proteins

Meal prepared with tempeh.
Image provided by Mun Alimentos.

gfi Brazil

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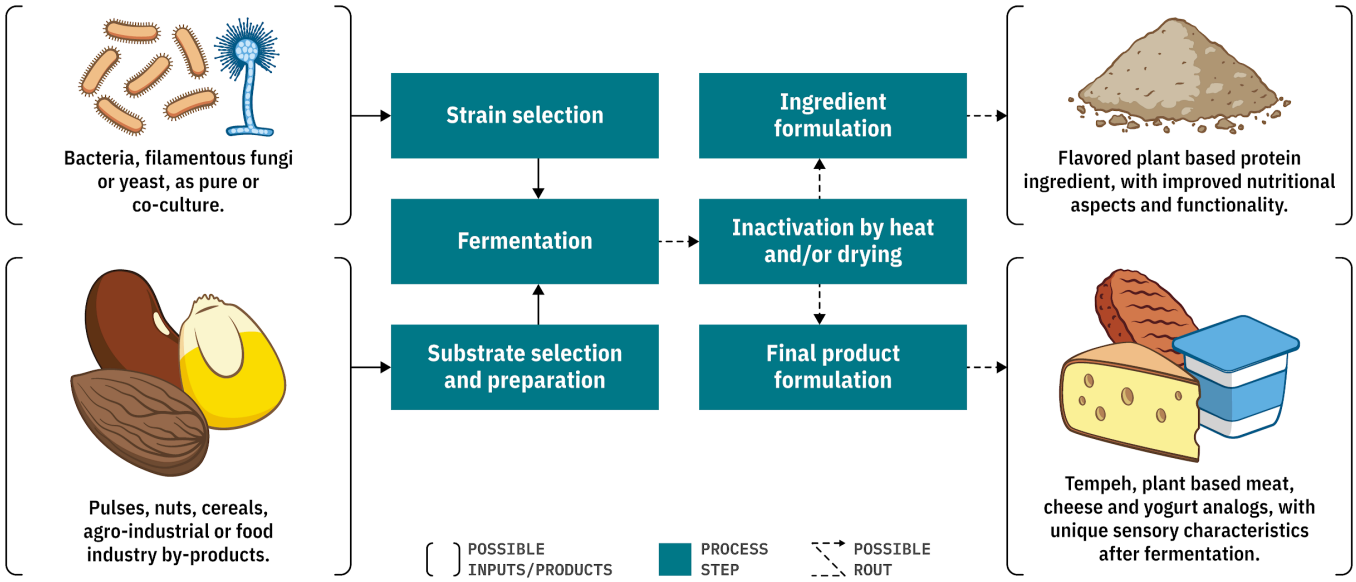
Fermentation is one of the most ancient preservation techniques ever developed by mankind, having existed since approximately 7000 BC. It has been widely used in food preservation and is currently applied in the manufacture of traditional foods such as cheese, yogurt, bread, beer, and wine. Recently, fermentation has also been used in the production of alternative proteins.

In traditional fermentation, microorganisms develop and produce metabolites that change the composition of food, improving sensory characteristics such as aroma, taste, texture and color. During this process, microorganisms, especially bacteria and yeasts, convert sugars into compounds such as organic acids and alcohols, giving the products distinct sensory characteristics. Such changes may also result in improved nutritional quality, digestibility and protein availability (Mannaa et al., 2021). Recently, evidence on the health benefits of consuming fermented products has piqued the interest of researchers (Valentino et al., 2024) and, consequently, of investors.

Graphical summary. *Potential pathways, raw materials, and alternative protein products obtained through the application of traditional fermentation technology as detailed in this fact sheet.*



1. Opportunities and market for traditional fermentation in the alternative protein sector

The increased demand for plant-based alternatives has led to a heightened interest in employing traditional fermentation techniques to develop non-animal-derived food products. Utilizing resources such as oilseeds, pulses, and grains presents a substantial opportunity to innovate upon traditional fermented foods, yielding distinctive flavors and textures (Goksen et al., 2023).

In 2022, US$ 39 million was invested in the sector of traditional fermentation applied to alternative proteins

In 2022, the traditional fermentation sector was responsible for US$ 39 million in investments (Good Food Institute, 2022). However, there is a small number of traditional fermentation startups developing alternative products around the world—about five *startups*—which shows that this potential is still little exploited. The study and use of different microorganisms, including the combination of one or more microbial cultures, can result in unique aromas and flavors, as well as boost the nutritional value of food. The exploration and diversification of starter cultures present a significant opportunity for application, particularly in diversifying the range of traditionally fermented products.

Source: Alternative Protein Company... (2024); Good Food Institute (2023).

Opportunities in the B2C* model: New products

Traditional fermentation provides a unique opportunity to transform already known products into new versions, driving innovation in the food industry towards meeting growing demands for healthy and sustainable options. Companies such as Chunk Foods and Planetarians use traditional fermentation and by-products of these processes to create unique plant-based meat products and whole cuts. In Brazil, there are companies focused on the production of dairy analogs using fermentation on plant substrates, such as Viveg, which produces fermented plant-based cheeses; Eat Fresco, which has plant-based, natural and probiotic yogurts; Vida Veg, which sells a line of several fermented cashew nut-based products, such as cream cheese; and NoMoo, which ferments cashew nut milk for cheese production.

Source: Good Food Institute (2023) and survey data from The Good Food Institute Brasil.
**Business-to-Consumer*

Opportunities in the B2B* model: Studies with plant-based proteins demonstrate that the use of fermentation can reduce undesirable flavors and aromas and increase the acceptance of analog products formulated with these ingredients

During fermentation, lipids (oils) and/or polysaccharides (carbohydrates) are degraded in the food matrix, releasing flavors and adding texture. This process can improve the sensory aspects of current plant-based products, such as those prepared with pea protein, whose flavor and aroma can become more attractive to consumers. Consequently, the fermentation process presents a strategic avenue for enhancing ingredient quality and effectively catering to the demands of the plant-based sector.

Source: Shi et al. (2021) and Behrens, Roig and Silva (2004).
**Business-to-Business*

Fermentation has the capacity to enhance the bioavailability of vital nutrients, including vitamins, minerals, and bioactive compounds, thereby facilitating their absorption within the human body	Fermentation can also increase the bioavailability of essential nutrients such as vitamins, minerals and bioactive compounds, making them more easily absorbable by the human body. Furthermore, traditional fermentation can also be used to reduce antinutrients present in certain plant-based foods, such as phytates and tannins, which can negatively interfere with the absorption of nutrients by the human body[1]. Furthermore, the microorganisms utilized in traditional food fermentation are typically part of the final product. Consequently, the intrinsic nutritional composition of the microorganisms themselves can potentially enhance the nutritional value of the product[2]. Also for this reason, these products may contain microorganisms that are beneficial to intestinal function, depending on the strain used and the viability of the microorganisms in the final product[3]. The incorporation of probiotic microorganisms* is an open field of innovation for these foods. *Source: 1- Horlacher, Oey and Agyei (2023); 2- Valentino et al. (2024); 3- Hidalgo-Fuentes et al. (2024).* **Probiotics are live microorganisms, usually bacteria and yeast, that when ingested in adequate amounts provide benefits to the body (Maftei et al., 2024).*

2. Why is traditional fermentation promising in Brazil?

Innovation opportunities in the market: **26% of Brazilians consume plant-based meats at least once a month. As for plant-based alternatives to milk and dairy products, the number increases to 48%**	The growing interest in and consumption of plant-based analog food products by Brazilian consumers also provides an opportunity to innovate in the sector by using traditional fermentation. It is possible to introduce products that deliver the previously noted health-promoting aspects, in addition to improved flavors. As traditional fermentation is not a complex technology, these innovations can be achieved with low investments and provide products with a more competitive final price. *Source: Lupetti and Casseli (2024).*

Scientific production: fermented plant-based beverages and their nutritional and probiotic potential

Brazilian research laboratories are augmenting their investigations into traditional fermentation methods to create functional plant-based products, including fermented beverages, that offer consumer health benefits. The research focuses on lactic acid bacteria, notably those of the *Lactobacillus* and *Bifidobacterium* genera, owing to their substantial probiotic potential for human health. Researchers in São Paulo are examining the utilization of water-soluble extracts derived from oats, almonds, soy, Brazil nuts, and rice to formulate functional beverages. These investigations encompass raw materials like oats, sunflower seeds, and soybeans. Outcomes of this research include fermented plant-based milks and yogurts characterized by elevated concentrations of bioactive compounds and enhanced bioavailability of nutrients like iron. These products are also assessed for their probiotic effectiveness, ensuring a minimum concentration of viable probiotic cells. Additionally, fermented products demonstrate increased antioxidant capacity due to a higher content of phenolic compounds and exhibit immunomodulatory properties[2,3].

Source: 1- Deziderio et al. (2023); 2- Penha et al. (2021); 3- Ferreira et al. (2022).

Scientific production: exploiting the wide availability of substrates of biodiversity

Lima et al. (2021) used the *Rhizopus oligosporus* fungus to ferment the by-product of *Anacardium othanianum*, known as cajuí, increasing the antioxidant capacity and protein content of the ingredient. Microbial proliferation enhances the nutritional composition of plant-based beverages. It also augments the solubility of plant proteins and enriches the bioavailability of minerals, amino acids, and vitamins.

Researchers of the Brazilian Agricultural Research Corporation (EMBRAPA) are studying the fermentation of babassu coconut to give an acidic flavor to coconut milk, making cheeses produced with coconut milk more similar to traditional cheeses, in research funded by the GFI under the Biomas program[1]. Another example from the same funding program using this technology is the project designated "Fermented products obtained from Brazil nut and babassu flours," developed at the State University of Campinas (UNICAMP), which aims to use Brazil nut and babassu flours as substrates for fermentation with *Saccharomyces cerevisiae* var. *boulardii*. The study is focused on the macronutrient composition, technological properties, probiotic potential, and bioactivity of the products. In addition, it includes scale-up and testing on meat analogs, integrating traditional Amazonian knowledge and scientific knowledge to promote health, food security, and income for Amazonian communities. Another project aiming to produce improved meat analogs was developed by ProVerde and funded by GFI's global research funding program. The study leverages solid-state fermentation to develop a functional and nutritionally enhanced peanut flour-based protein ingredient for application in meat analogs to obtain the desired fibrous texture.

Source: 1- Benevides et al. (2023).

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