FACT SHEET

# Precision Fermentation: the technology that is revolutionizing the alternative protein industry

*Cheese produced with dairy protein obtained by precision fermentation. Image provided by New Culture.*

gfi Brazil

# Credits


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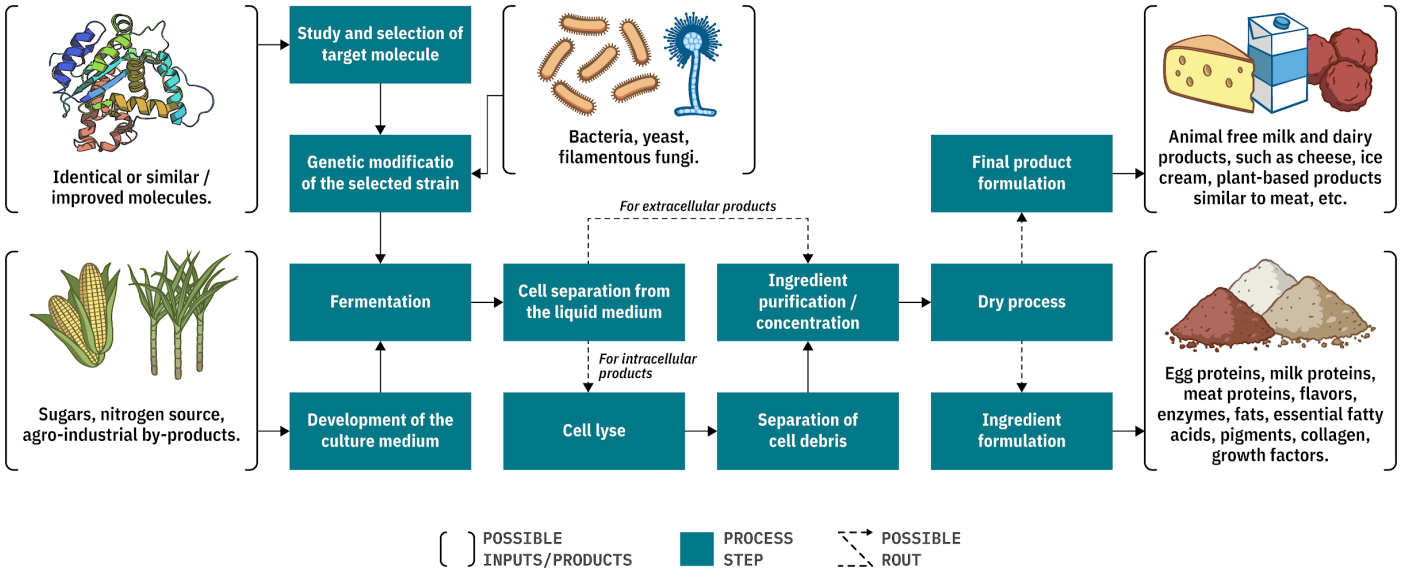
Have you ever imagined tasting a cheese with a characteristic texture and flavor, without it being made from cow's milk? Or eating a plant-based burger without noticing that you're not eating animal meat? Precision fermentation enables delivering these solutions by producing the same proteins present in animal-based products. These ingredients provide characteristic flavor, color and juiciness to plant-based analogs or cultivated meat food products (Liu; Aimutis; Drake, 2024).

This technological approach employs genetic engineering techniques to make microorganisms, such as bacteria and fungi, capable of producing proteins that are identical to animal proteins (Hilgendorf et al., 2024). The microorganisms are genetically modified (GMO – Genetically Modified Organism) to act as "small factories" for the production of these molecules (Good Food Institute, 2022, 2023), producing ingredients such as whey protein, casein (milk protein), egg albumin (egg white protein), enzymes, fats, dyes and vitamins in large quantities (Boukid et al., 2023). These ingredients can be used by the industry to compose alternatives to meat, dairy products and eggs, in plant-based and cultivated meat products (Good Food Institute, 2023).

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




## 1. Market trends and growth prospects

Precision fermentation was driven by the advancement of molecular biology and genetic engineering, especially in the early decades of the 21st century (Cheng et al., 2022). In the 1980s, this technology was initially developed for the production of human insulin through recombinant *Escherichia coli*, and in the 1990s it was also used for food applications in the production of chymosin for cheese and riboflavin (vitamin B2). The most significant advances in precision fermentation for specific proteins have recently arisen, and the technology has expanded widely in the food industry (Liu; Aimutis; Drake, 2024). Therefore, the microorganisms' fast growth leverages to produce specific functional ingredients more efficiently, including proteins identical to those produced by animals, consequently dissociating the production from the animals. This controlled and efficient fermentation process takes place within bioreactors and can even remove allergenic components found in animal molecules.

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| **US$ 382 million was invested in the precision fermentation sector in 2022** | In the global context, 4.1 billion dollars were invested between 2013 and 2023 in fermentation for the production of alternative proteins (Good Food Institute, 2023). In 2022, US$382 million was invested only in the precision fermentation sector (Good Food Institute, 2022).<br><br>*Source: Good Food Institute (2023).* |
| **Data from 2023 indicates that 60 *startups* in the world are operating in the production of alternative proteins using precision fermentation** | Until 2019, there were only 13 *startups* that used precision fermentation as the main technology to obtain products and inputs for the alternative protein sector. In 2023, a new GFI report surveyed about 60 *startups* in this sector. This represents an almost 80% increase in the number of new businesses focused on precision fermentation applied to alternative proteins over the past 4 years.<br><br>*Source: Good Food Institute (2023) and Alternative Protein Company... (2024).* |
| **In Brazil, four surveyed *startups* operate in the precision fermentation-derived alternative protein sector** | The Brazilian ecosystem is at an early stage of development, and some *startups* are already innovating by introducing solutions in the sector: Future Cow Technologies, Ark Bio Solutions and UpDairy develop dairy proteins through precision fermentation, and Biolinker produces growth factors for cultivated meat.<br><br>*Source: The Good Food Institute Brasil survey data.* |
| **Joining forces: The Precision Fermentation Alliance was established in 2023** | In 2023, an alliance of nine precision fermentation companies was created to facilitate communication with consumers and regulation for these products: the Precision Fermentation Alliance. Such associations are key agents in knowledge exchange, institutional support engagement, organization around regulatory standards, and raising people's awareness of the advances and benefits of this technology in food production.<br><br>*Source: https://www.pfalliance.org/* |

## 2. Bringing solutions for challenges in the alternative protein sector

Precision fermentation-derived ingredients can contribute to overcoming several technological challenges in alternative protein products:

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| **Precision fermentation-derived functional ingredients offer an excellent solution to the technological challenges of creating plant-based products that replicate the sensory experience of meat by significantly improving the taste, appearance, and juiciness of these products** | An example of how precision fermentation can be a key tool for the alternative protein sector is the production of hemeproteins such as myoglobin, a molecule occurring naturally in animals that is responsible for the proper color and flavor of beef (Liu et al., 2024). To this end, an alternative is to produce bovine myoglobin itself or similar molecules, such as Impossible Foods' soy leghemoglobin, which is capable of adding color, flavor and juiciness that are typical of fried or grilled meat products.<br>Dairy proteins, such as casein, and whey proteins, such as beta-lactoglobulin or lactoferrin, can also be produced. Using some of these proteins in food formulations is essential to obtain specific characteristics such as texture, elasticity and melting that are typical of cheese. The startup Change Foods, for example, uses this strategy, obtaining proteins from precision fermentation, to solve functionality challenges faced in the development of plant-based cheese analogs.<br>Egg white proteins can also be produced by precision fermentation, such as ovomucoid (a glycoprotein produced by Every) and ovalbumin. These proteins have important functionalities for food formulations, such as foaming and emulsifying capacity.<br>*Source: Tachie, Nwachukwu and Aryee (2023).* |
| **Precision fermentation can overcome challenges in obtaining inputs to produce cultivated meat** | Cultivated meat production involves the use of various inputs, and precision fermentation is an essential technological platform for recombinant protein production to compose animal-free culture media. Some of these inputs include growth factors, albumin, insulin, and transferrin, which can be efficiently produced to supply this cultivated meat production chain.<br>*Source: Yamanaka et al. (2023); The Science of... (2021).* |

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| **Currently, food enzymes are produced predominantly through recombinant microorganisms, and there are opportunities for the production of new enzymes, considering the alternative protein sector[1]** | Enzymatic treatment can solve important challenges of plant proteins, such as low solubility, low gelling and cross-linking capacity, bitterness, grain notes, other undesirable flavors, low emulsification, and low capacity for binding with fats and water.<br>In addition, bottlenecks as to the cost of culture media used for cultivated meat production and alternative substrate use for fermentation can be solved by using enzymatic cocktails obtained by precision fermentation, either a proteolytic cocktail, considering the generation of amino acid hydrolysate for cell culture[2], or glycosylhydrolases to convert complex carbohydrate sources, such as lignocellulosic residues, into fermentable sugars[3].<br>*Source: 1- Good Food Institute Brasil (2022); 2- Flaibam and Goldbeck (2024); 3- Lima et al. (2022).* |
| **Precision fermentation can potentially reduce the environmental impacts of protein production** | Preliminary Life Cycle Assessment analysis studies suggest that precision fermentation technology can reduce environmental impacts in different impact categories, such as global warming potential and land use, whether in the production of dairy proteins[1] or egg white proteins[2] by precision fermentation. The studies note that most impacts and trade-offs between impact categories can potentially be further reduced using a low-carbon energy source. Thus, these reductions in greenhouse gas emissions are intrinsically associated with the energy source used in the production process, indicating the use of renewable sources as a solution.<br>*Source: 1- Geistlinger, Briggs and Nay (2023); 2- Järviö et al. (2021).* |

## 3. Why is precision fermentation promising in Brazil?

Brazil has a robust scientific community and abundant natural resources that favor progress in the field of precision fermentation. In addition, the presence of a competent agency (National Technical Commission on Biosafety – CTNBio) and well-established biosafety laws provides a conducive environment for the development and implementation of precision fermentation technologies. Currently, there are a total of 64 strains and derivatives of genetically modified microorganisms authorized for commercial use in Brazil (CTNBio data from April 8, 2024), including a soy leghemoglobin produced by *Picchia pastoris* for use in ground meat analog products for human consumption (Technical Opinion 7,060/2020).

In addition, the country already has model biorefineries in operation, which employ advanced precision fermentation technologies for the efficient and sustainable production of a variety of products using substrates such as sugarcane.

## Opportunities exist to offer solutions to the Brazilian plant-based analog product market, which reached a valuation of US$ 226 million and exhibited a growth rate of 38% in 2023.

According to Euromonitor data, the estimated sales of plant-based meat analogs in Brazil were US$226 million or 1.1 billion reais in 2023. These products still face challenges in mimicking the consumer experience with traditional products, and the use of precision fermentation-derived ingredients is an opportunity to improve them, potentially attracting even more consumers and investments to the country.

*Source: Euromonitor Passport, Meat and Seafood Substitutes, January 2024; and Plant-based Milk, October 2023 (Databook, 2024).*

## Potential for introduction into the cultivated meat under development supply chain

The Brazilian company BRF, in 2021, made a million-dollar investment in the Israeli startup Aleph Farms for cultivated meat production in Brazil[1]. In addition, the company JBS plans to invest US$ 100 million over a five-year period (2021 to 2025) to become one of the world's leading manufacturers of cultivated meat. In September 2023, JBS began building the "JBS Biotech Innovation Center" research center in Florianópolis, expected to begin operation in late 2024[2]. These new businesses depend on the creation of a supply chain, which constitutes an opportunity for expanding the market for traditional suppliers of animal feed inputs. For example, there are seven registered GMO microorganisms and their derivatives used for animal feed in Brazil[3]; these include some amino acids used in animal feed supplementation that could also be used as inputs in the cultivared meat industry, since the nutritional needs of animals can be very similar to the nutrient needs of cells during cell culture.

*Source: 1- BRF Faz Aporte... (2021); 2- Brandão (2023); 3- Liberação Comercial... (2024).*

## Studies indicate that Brazil has higher acceptance rates for precision fermentation-derived foods, compared with Germany, India, the United Kingdom and the USA

Regarding the acceptance of these products in Brazil, Thomas and Bryant (2021) reported that the country showed the lowest rejection rates for cheeses produced by precision fermentation, compared with Germany, India, the United Kingdom and the USA. The research showed that 90% of Brazilian participants are willing to try and buy a cheese product without animal ingredients after reading a detailed explanation of precision fermentation and the sensory properties of the resulting ingredients/products. This demonstrates that precision fermentation products are highly likely to be well-accepted by Brazilian consumers.

*Source: Thomas and Bryant (2022).*

## 93% of the surveyed Brazilian researchers use agro-industrial wastes as components of the culture medium used for precision fermentation[1]

As for the use of wastes as fermentation substrate, there is potential for the development of new strains capable of metabolizing these diverse substrates, including sugars, complex carbohydrates, lactate, glycerol, etc. In addition, there are studies focused on the development of microbial platforms for the production of enzymes that enable obtaining fermentable sugars from lignocellulosic biomass[2]. Thus, there is a notable potential to combine the genetic techniques already under study with the national raw materials and feedstocks to develop products identical to animal-based products through precision fermentation in an affordable manner.

*Source: 1- survey conducted by The Good Food Institute Brazil; 2- Lima et al. (2022).*

## Scientific production in Brazil

Beyond contributions to microbial chassis development and genetic modification techniques such as CRISPR/Cas9* that can be exported for different applications[1,2], Brazilian researchers already contribute to scientific production focused on alternative proteins. Researchers from the Federal University of Santa Catarina noted the potential of precision fermentation as an alternative for obtaining animal proteins in a review article that addresses environmental impact data related to current global food production, in addition to reporting the main proteins already produced by precision fermentation, with a particular focus on those used in the food and nutraceutical industries[3]. Regarding the production of dairy proteins that can be obtained by precision fermentation, an article by researchers from the Federal University of Paraná provided a comprehensive review of articles and patents to understand the current status and advances in the production of recombinant dairy proteins. The authors note the promising future of the technology and argue that continued research and development are essential to optimize the technology and increase its commercial viability to meet the growing demand for sustainable dairy alternatives[4].

*Source: 1- Mélo et al. (2022); 2- Lima et al. (2022); 3- Knychala et al. (2024); 4- Piazenski et al. (2024).*

**CRISPR/Cas9 is a kind of 'genetic scissors,' which enables changing part of the genetic code of a cell. With such 'scissors,' it is possible, for example, to 'cut' a specific part of the DNA, leading the cell to produce certain proteins or not. The technique revolutionized gene editing with virtually infinite editing possibilities (Redman et al., 2016).*

## Regulation in Brazil

Recently, the Brazilian Health Regulatory Agency (ANVISA) published RDC Resolution No. 839, of December 14, 2023, regulating the registration of novel foods and ingredients without a historical record of safe consumption in the country, including those originating from fermentation. This resolution established the process of assessing the safety of these foods and ingredients for human consumption. This situates Brazil at the same regulatory framework level as other countries already within ongoing initiatives on precision fermentation, including those applied to the alternative protein sector. Despite that, experts note that issues concerning the inspection of the production process have not yet been detailed. Other fermentation methods, such as those used in the production of beer and wine, are already regulated, but it is necessary to improve the safety assessment procedure for novel foods and ingredients, either at ANVISA or at the Ministry of Agriculture and Livestock (MAPA). The expectation is that, with clearer regulation, companies will invest in the sector, resulting, over the years, in a higher supply of these products in the Brazilian market, potentially at competitive prices; however, products of this type are expected to take some time to reach consumers.

In the case of precision fermentation, the processes, products and ingredients obtained — if they contain genetically modified organisms or derivatives — must comply with the provisions of Law No. 11,105, of March 24, 2005, among other relevant regulations. Commercial authorization is given after a positive assessment of the safety of these products.

*Source: Brasil (2005, 2023).*

# References


ALTERNATIVE PROTEIN COMPANY Database. *Good Food Institute*, Washington, DC, 2024. Disponível em: https://gfi.org/resource/alternative-protein-company-database/. Acesso em: 7 nov. 2024.

BARROS, K. O. *et al*. Oxygenation influences xylose fermentation and gene expression in the yeast genera Spathaspora and Schefersomyces. *Biotechnology for Biofuels and Bioproducts*, Berlin, v. 17, n. 20, 2024. DOI: https://doi.org/10.1186/s13068-024-02467-8.

BOUKID, F. *et al*. Bioengineered Enzymes and Precision Fermentation in the Food Industry. *International Journal of Molecular Science*, Basel, v. 24, n. 12, 10156, June 2023. DOI: 10.3390/ijms241210156.

BRANDÃO, R. Carne de laboratório: por que a JBS faz aposta milionária em proteína cultivada? *Exame Invest*, São Paulo, 16 maio 2023. Disponível em: https://exame.com/invest/mercados/carne-de-laboratorio-por-que-a-jbs-faz-aposta-milionaria-em-proteina-cultivada/. Acesso em: 8 nov. 2024.

BRASIL. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. *Resolução da Diretoria Colegiada nº 839, de 14 de dezembro de 2023*. Brasília, DF: Ministério da Saúde, 2023. Disponível em: https://antigo.anvisa.gov.br/documents/10181/6582266/RDC_839_2023_.pdf/a064b871-55dd-44b9-ab40-16ca7672497d. Acesso em: 8 nov. 2024.

BRASIL. Presidência da República. *Lei nº 11.105, de 24 de março de 2005*. Brasília, DF: Presidência da República, 2005. Disponível em: https://www.planalto.gov.br/ccivil_03/_ato2004-2006/2005/lei/l11105.htm. Acesso em: 8 nov. 2024.

BRF FAZ APORTE de US$ 2,5 milhões na Aleph Farms para produzir carne cultivada. *Forbes Money*, [*s. l.*], 7 jul. 2021. Disponível em : https://forbes.com.br/forbes-money/2021/07/brf-faz-aporte-de-us-25-milhoes-na-aleph-farms-para-produzir-carne-cultivada/. Acesso em: 27 maio 2024.

BROAD, G. M. *et al*. Framing the futures of animal-free dairy: Using focus groups to explore early-adopter perceptions of the precision fermentation process. *Frontiers in Nutrition,* [*s. l.*], v. 9, Oct. 2022. DOI: 10.3389/fnut.2022.997632.

CHENG, A. *et al*. Genetics Matters: Voyaging from the Past into the Future of Humanity and Sustainability. *International Journal of Molecular Science*, Basel, June, v. 23, n. 7, 3976, Apr. 2022. DOI: 10.3390/ijms23073976.

DATABOOK. *GFI Brasil*, [*s. l.*], 2024. Disponível em: https://gfi.org.br/databook/. Acesso em: 8 nov. 2024.

FLAIBAN, B.; GOLDBECK, R. Effects of enzymes on protein extraction and post-extraction hydrolysis of non-animal agro-industrial wastes to obtain inputs for cultured meat. Food and Bioproducts Processing, Amsterdam, v. 143, p. 117-127, Jan. 2024. DOI: 10.1016/j.fbp.2023.11.001.

GEISTLINGER, T.; BRIGGS, N.; NAY, K.; Chapter 21 - Case study on whey protein from fermentation, Cellular Agriculture, *Academic Press*, Pages 323-342, 2024. DOI: 10.1016/B978-0-443-18767-4.00021-4.

GOOD FOOD INSTITUTE. *2022 State of the Industry Report* – Fermentation: Meat, seafood, eggs and dairy. Washington, DC: GFI, 2022. Disponível em: https://gfi.org/wp-content/uploads/2023/01/2022-Fermentation-State-of-the-Industry-Report-1.pdf. Acesso em: 28 maio 2024.

GOOD FOOD INSTITUTE. *2023 State of the Industry Report* – Fermentation: Meat, seafood, eggs and dairy. Washington, DC: GFI, 2023. Disponível em: https://gfi.org/resource/fermentation-state-of-the-industry-report/. Acesso em: 16 abr. 2024.

GOOD FOOD INSTITUTE BRASIL. *Serie tecnológica das Proteínas Alternativas*: Fermentação e processos fermentativos. São Paulo: Tiki Books; GFI Brasil, 2022. *E-book*. Disponível em: https://gfi.org.br/wp-content/uploads/2022/11/Serie-Tecnologica-Fermentacao-e-processos-fermentativos-GFI-Brasil.pdf. Acesso em: 7 nov. 2024.

HILGENDORF, K.; WANG, Y.; MILLER, M.J.; JIN, Y.S. Precision fermentation for improving the quality, flavor, safety, and sustainability of foods. *Curr Opin Biotechnol*, 86:103084, Apr. 2024. DOI: 10.1016/j.copbio.2024.103084.

JÄRVIÖ, N. *et al*. Ovalbumin production using *Trichoderma reesei* culture and low-carbon energy could mitigate the environmental impacts of chicken-egg-derived ovalbumin. *Nature Food*, Berlin, v. 2, p. 1005-1013, 16 Dec. 2021. DOI: 10.1038/s43016-021-00418-2.

KNYCHALA, M. M. *et al*. Precision Fermentation as an Alternative to Animal Protein, a Review. *Preprint Review*, Basel, v. 1, 1 May 2024. DOI: 10.20944/preprints202405.0005.v1.

LIBERAÇÃO COMERCIAL – Comissão Técnica Nacional de Biossegurança. *CTNBio*, Brasília, DF, 2024. Disponível em: http://ctnbio.mctic.gov.br/liberacao-comercial?p_p_id=110_INSTANCE_SqhWdohU4BvU&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-2&p_p_col_count=3&_110_INSTANCE_SqhWdohU4BvU_struts_action=%2Fdocument_library_display%2Fview_file_entry&_110_INSTANCE_SqhWdohU4BvU_fileEntryId=2238172#/liberacao-comercial/consultar-processo. Acesso em: 8 nov. 2024.

LIMA, E. A. *et al*. Development of an economically competitive Trichoderma-based platform for enzyme production: Bioprocess optimization, pilot plant scale-up, techno-economic analysis and life cycle assessment. *Bioresource Technology,* London, v. 364, 128019, 2022.

LIMA, P. B. A. *Engenharia metabólica em Pichia pastoris para produção de L-ácido lático a partir de glicerol, um resíduo da indústria de biodiesel*. 2017. Tese (Doutorado em Ecologia) – Instituto de Ciências Biológicas, Universidade de Brasília, Brasília, DF, 2017.

LIU, Y.; AIMUTIS, W. R.; DRAKE, M. Dairy, Plant, and Novel Proteins: Scientific and Technological Aspects. *Foods*, Basel, v. 13, n. 7, 1010, 2024.

MÉLO, A. H. F. D. *et al*. Evaluation of *Saccharomyces cerevisiae* modified via CRISPR/ Cas9 as a cellulosic platform microorganism in simultaneously saccharification and fermentation processes. *Bioprocess and Biosystems Engineering*, Berlin, v. 46, n. 1111-1119, Aug. 2022. DOI: 10.1007/s00449-022-02765-1.

MICRORGANISMOS GENETICAMENTE MODIFICADOS e derivados aprovados comercialmente no Brasil para uso industrial. *CTNBio*, Brasília, DF, 7 dez. 2020. Disponível em: https://ctnbio.mctic.gov.br/documents/566529/1687332/Tabela+de+Microorganismos+Aprovados+para+Comercializa%C3%A7%C3%A3o/7b7a17fd-ef84-4dfd-b2b4-fe5900745be2;jsessionid=5AD1647E950C62CC95FD2DC5613691AC.columba?version=1.7. Acesso em: 27 maio 2024.

NOVA PESQUISA do GFI Brasil aponta os principais comportamentos e perfis do consumidor de alternativas plant-based no Brasil. *GFI Brasil*, [*s. l.*], 2024. Disponível em: https://gfi.org.br/nova-pesquisa-do-gfi-brasil-aponta-os-principais-comportamentos-e-perfis-do-consumidor-de-alternativas-plant-based-no-brasil/. Acesso em: 27 maio 2024.

PIAZENSKI, I. N. et al. From lab to table: The path of recombinant milk proteins in transforming dairy production. *Trends in Food Science & Technology*, v. 149, 2024. DOI: 10.1016/j.tifs.2024.104562.

REDMAN, M. *et al*. What is CRISPR/Cas9? *Archives of disease in childhood. Education and practice edition*, London, v. 101, n. 4, p. 213-215, 2016. DOI: 10.1136/archdischild-2016-310459.

SANTOS, F. D. *Desenvolvimento de coquetéis enzimáticos customizados para a hidrólise de substratos com elevados teores de hemicelulose e lignina*. 2021. Tese (Doutorado em Biotecnologia Industrial) – Escola de Engenharia de Lorena, Universidade de São Paulo, Lorena, 2021.

TACHIE, C.; NWACHUKWU, I. D.; ARYEE, A. N. A. Trends and innovations in the formulation of plant-based foods. *Food Production, Processing and Nutrition Review*, Berlin, v. 5, 16, Mar. 2023. DOI: 10.1186/s43014-023-00129-0.

TENG, T. S. *et al*. Fermentation for future food systems: Precision fermentation can complement the scope and applications of traditional fermentation. *EMBO Reports*, [*s. l.*], v. 22, n. 5, e52680, 2021. DOI: 10.15252/embr.202152680.

THE SCIENCE OF Cultivated meat: Cell culture media. *Good Food Institute*, Washington, DC, 2021. Disponível em: https://gfi.org/science/the-science-of-cultivated-meat/?_gl=1*14bngkk*_up*MQ..*_ga*MTY2MjU4ODczMy4xNzMzMzk5ODU3*_ga_TT1WCK8ETL*MTczMzM5OTg1NS4xLjEuMTczMzM5OTg1NS4wLjAuMA..#Introduction . Acesso em: 7 nov. 2024.

THOMAS, Z.; BRYANT, C. Don't Have a Cow, Man: Consumer Acceptance of Animal-Free Dairy Products in Five Countries. *Frontiers in Sustainable Food Systems*, [*s. l.*], v. 5, June 2022. DOI: 10.3389/fsufs.2021.678491.

TUBB, C.; SEBA, T. Rethinking food and agriculture 2020-2030: the second domestication of plants and animals, the disruption of the cow, and the collapse of industrial livestock farming. *Industrial Biotechnology*, New Rochelle, v. 17, n. 2, p. 57-72, 2021.

VITOR, A. B. *et al*. Aplicações da CRISPR/Cas9 em fundos com potencial na síntese de enzimas produtoras de bioetanol. *In*: CONGRESSO BRASILEIRO INTERDISCIPLINAR EM CIÊNCIA E TECNOLOGIA, 31 ago.-4 set. 2020, [*s. l.*]. *Anais* [...]. 2020. [*S. l.*]: CoBICET, 2020.

WHAT IS SOY leghemoglobin, or heme? *Impossible Foods*, [*s. l.*], 2024. Disponível em: https://faq.impossiblefoods.com/hc/en-us/articles/360019100553-What-is-soy-leghemoglobin-or-heme. Acesso em: 27 maio 2024.

YAMANAKA, K. *et al*. Development of serum-free and grain-derived-nutrient-free medium using microalga-derived nutrients and mammalian cell-secreted growth factors for sustainable cultured meat production. *Nature Scientific Reports*, Berlin, v. 13, 498, Jan. 2023. DOI: 10.1038/s41598-023-27629-w.

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