

WHAT IS SOY LEGHEMOGLOBIN?

A Guide to a Unique Heme Ingredient

Soy leghemoglobin is a new heme ingredient originating from plants, which is produced at scale through the use of both genetic engineering and precision fermentation. These technologies have been used for decades to produce ingredients found in common food products and vitamins, but only recently used to create an ingredient for a plant-based meat product.

Food Frontier has developed this resource to introduce this unique protein developed and used exclusively by Impossible Foods and explain how it is processed into an ingredient and address frequently asked questions.

What is soy leghemoglobin?

Soy leghemoglobin is a protein found in the root nodules of soybeans. Hemoglobin is a protein that contains heme, the molecule that contains iron and transports oxygen in animals, humans and plants. All living animal and plant cells contain heme. Heme is found in high quantities in blood, but is also found in legumes such as soy in the form of leghemoglobin.^{1,2}

Why is soy leghemoglobin an ideal ingredient to add meat-like flavour, and enhance nutrition?

The soy leghemoglobin protein is used by Impossible Foods to enhance its products with a meat-like flavour.³ It is a separate and additional ingredient to the soybean protein used by the company as the base ingredient of its products. Soy leghemoglobin contains the iron molecule heme, which plays a central role during cooking to

form and release volatile aroma molecules. These molecules create the rich-umami flavour of meat.⁴

Beyond its flavour characteristics, heme also offers nutritional benefits. Heme contains a form of iron which is better absorbed by the body than non-heme iron (the type most commonly found in plant foods).⁵ This means the iron levels in Impossible Foods' products represent the same bioavailability (body absorption) of iron found in animal meat.



Soybean root nodule on the roots of a soy plant.

Credit: [American Society of Agronomy](#)

How soy leghemoglobin is produced at scale

As it is not environmentally or economically sustainable to harvest enough soy leghemoglobin from soy plants, soy leghemoglobin is produced at scale through a combination of genetic engineering and fermentation technologies.⁶

First, the DNA that encodes leghemoglobin is extracted from a soy plant. Then, the soy DNA sequence is inserted into a yeast's genome (*Pichia pastoris*), enabling the yeast to produce soy

¹ Wolf J. The Microbial Reasons Why the Impossible Burger Tastes So Good. American Society for Microbiology. [Internet] 2019 May 16. Available from: <https://asm.org/Articles/2019/May/The-Microbial-Reasons-Why-the-Impossible-Burger-Ta> ("Website," n.d.)

² Barrett, S. How the Impossible Burger is changing the debate over GMO foods. CNBC. [Internet- 2020 Feb 13. Available from: <https://www.cnbc.com/2020/02/13/how-the-impossible-burger-is-changing-the-debate-over-gmo-foods.html>

³ Fraser R et al.. Safety Evaluation of Soy Leghemoglobin Protein Preparation Derived From *Pichia pastoris*, Intended for Use as a Flavor Catalyst in Plant-Based Meat. International journal of toxicology, 37(3), 241–262 [Internet] 2018. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5813221/>

⁴ Wolf J. The Microbial Reasons Why the Impossible Burger Tastes So Good. American Society for Microbiology. [Internet] 2019 May 16. Available from: <https://asm.org/Articles/2019/May/The-Microbial-Reasons-Why-the-Impossible-Burger-Ta>

⁵ Iron. Harvard T Chan School of Public Health [Internet] 2021. Available from: <https://www.hsph.harvard.edu/nutritionsource/iron/>

⁶ Bandoim L. What The FDA's Decision About Soy Leghemoglobin Means For Impossible Burger. Forbes [Internet] 2019 Dec 20. Available from: <https://www.forbes.com/sites/lanabandoim/2019/12/20/what-the-fdas-decision-about-soy-leghemoglobin-means-for-impossible-burger/?sh=6e0659b057f6>

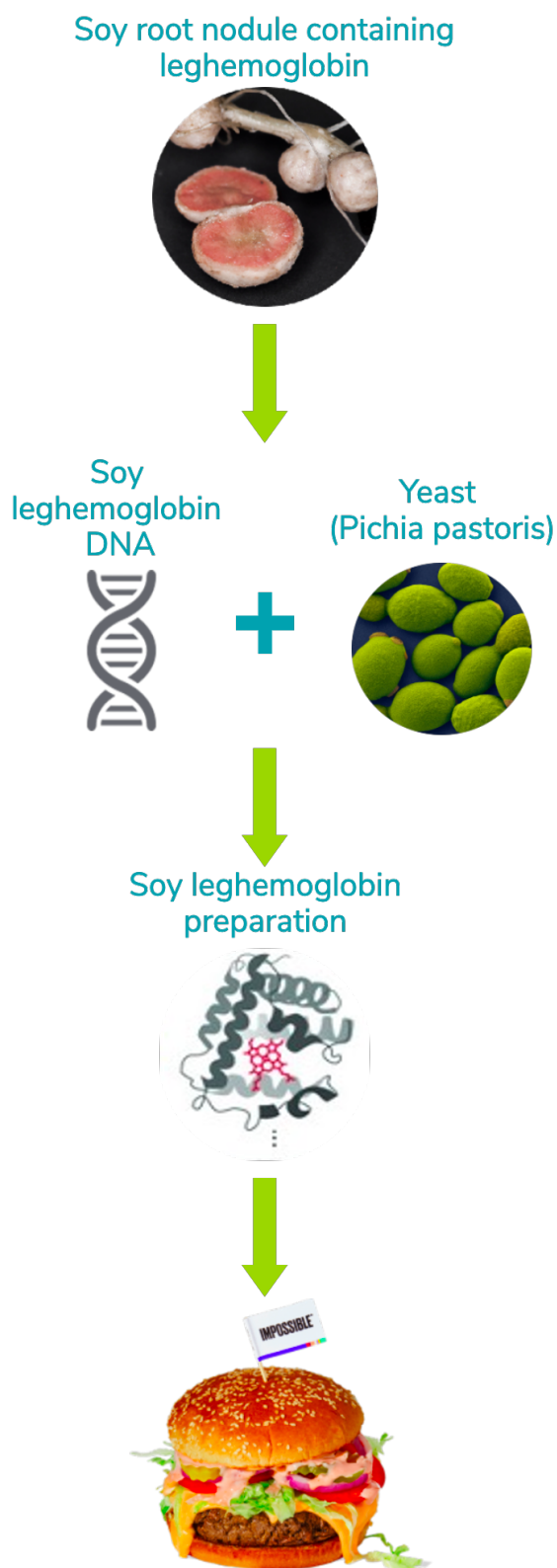
leghemoglobin. This completes the genetic engineering part of the process.

The next step leverages the technology of precision fermentation – that is, the use of microorganisms such as yeast, and the process of fermentation, to grow specific ingredients such as proteins and fats.

These two technologies have been used together for decades to make ingredients such as rennet (commonly used in hard cheeses), and vitamins such as B12 for nutritional supplements and fortified processed foods.

Through the natural biological process of fermentation, the modified yeast multiplies, and each new yeast cell also produces the soy leghemoglobin protein. Afterwards, soy leghemoglobin is isolated from the yeast and is added to the recipe of soybean protein and other ingredients that make up Impossible Foods plant-based beef.⁷

Because soy leghemoglobin is produced using gene technology, it is labelled as genetically modified in the ingredient list. The soy leghemoglobin ingredient created in this process has been reviewed and recognised as safe for use by Food Standards Australia and New Zealand, the statutory authority on food standards in both countries.⁸ Soy leghemoglobin has also been deemed safe for consumption by the food regulatory bodies of the United States, Canada, Hong Kong, Macau and Singapore.



Above: Process of creating soy leghemoglobin at scale

⁷ Fraser R et al.. Safety Evaluation of Soy Leghemoglobin Protein Preparation Derived From Pichia pastoris, Intended for Use as a Flavor Catalyst in Plant-Based Meat. International journal of toxicology, 37(3), 241–262.[Internet] 2018. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5813221/>

⁸ Food Standards Australia New Zealand. Australia New Zealand Food Standards Code – Schedule 26 – Food produced using gene technology [Internet] Available from: <https://www.legislation.gov.au/Details/F2021C00760>

SOY LEGHEMOGLOBIN FAQs

What are the benefits of soy leghemoglobin?

Soy leghemoglobin is an ingredient that contains the iron molecule heme, which imparts the flavour and aroma of meat in plant-based meat products, yet without the need for animal ingredients. The presence of heme in soy leghemoglobin provides a source of readily bioavailable iron.

Is soy leghemoglobin safe to eat?

Yes – the soy leghemoglobin ingredient has been recognised as safe for human consumption by Food Standards Australia and New Zealand (FSANZ).⁹ Thus, FSANZ has approved the sale of soy leghemoglobin when used as prescribed by the regulations in AU/NZ.

Soy leghemoglobin has also been deemed safe for consumption by the food regulatory bodies of the United States,¹⁰ Canada,¹¹ Hong Kong,¹² Macau¹³ and Singapore.¹⁴

How is genetic engineering used to produce soy leghemoglobin sustainably?

The use of genetic engineering, combined with precision fermentation, is required to create the soy leghemoglobin ingredient at scale.¹⁵

These combined technologies enable the sustainable production of soy leghemoglobin.¹⁶ Instead of growing and harvesting millions of soy plants to obtain heme from the root nodules, which

would promote erosion and release carbon stored in the soil, substantial amounts of soy leghemoglobin can be produced using fermentation rather than agriculture.¹⁷

First, DNA is extracted from a soybean root nodule. The DNA is inserted into the yeast *Pichia pastoris*, which converts a carbon source like sugar into leghemoglobin. The yeast is the organism which is considered genetically modified.¹⁸

Pichia pastoris is a strain of yeast that has been studied for decades and that has been used to grow proteins across both food preparation¹⁹ and therapeutics.

Due to the use of gene technology, GM labelling is required. This means for complete consumer transparency, the end ingredient will be listed as “soy leghemoglobin (genetically-modified)”.

Is soy leghemoglobin an ingredient used by other plant-based meat companies?

No. Impossible Foods’ proprietary production methods and use of the soy leghemoglobin in its products are patented in Australia and New Zealand.

Do other plant-based meat products sold in Australia and New Zealand contain ingredients produced using genetic engineering/genetic modification?

No; no other plant-based meat products sold in Australia and New Zealand contain ingredients

⁹ Food Standards Australia New Zealand. A1186 – Soy Leghemoglobin in meat analogue products [Internet] Available from:

<https://www.foodstandards.gov.au/code/applications/Pages/A1186.aspx>

¹⁰ FDA. FDA approval of soy leghemoglobin as a color additive is now effective. U.S. Food & Drug Administration. [Internet] 2019 Dec 17. Available from:

<https://www.fda.gov/news-events/fda-brief/fda-brief-fda-approval-soy-leghemoglobin-color-additive-now-effective>

¹¹ Government of Canada. Soy leghemoglobin (LegH) preparation as an ingredient in a simulated meat product and other ground beef analogues. Health Canada. [Internet] 2021. Available from: <https://www.canada.ca/en/health-canada/services/food-nutrition/genetically-modified-foods-other-novel-foods/approved-products/soy-leghemoglobin/document.html>

¹² FSANZ, Approval report – Application A1186 Soy leghemoglobin in meat analogue products. Page 10. Food Standards Australia New Zealand. [Internet] 2020 Dec 15. Available from:

<https://www.foodstandards.gov.au/code/applications/Documents/A1186%20Approval%20Report.pdf>

¹³ FSANZ, Approval report – Application A1186 Soy leghemoglobin in meat analogue products. Page 10. Food Standards Australia New Zealand. [Internet] 2020 Dec 15. Available from:

<https://www.foodstandards.gov.au/code/applications/Documents/A1186%20Approval%20Report.pdf>

¹⁴ Singapore Food Regulations. Food Additives Permitted Under The Singapore Food Regulations. [Internet] 2020 June 30. Available from:

<https://www.sfa.gov.sg/docs/default-source/tools-and-resources/resources-for-businesses/list-of-food-additives-permitted-under-food-regulations.pdf>

¹⁵ Wolf J. The Microbial Reasons Why the Impossible Burger Tastes So Good. American Society for Microbiology. [Internet] 2019 May 16. Available from: <https://asm.org/Articles/2019/May/The-Microbial-Reasons-Why-the-Impossible-Burger-Ta>

¹⁶ Impossible Foods. Do Your Products Contain Genetically Modified Ingredients? Impossible Foods Website. [Internet] Available from: <https://faq.impossiblefoods.com/hc/en-us/articles/360023038894-Do-your-products-contain-genetically-modified-ingredients->

¹⁷ Bandoim L. What The FDA’s Decision About Soy Leghemoglobin Means For Impossible Burger. Forbes [Internet] 2019 Dec 20. Available from: <https://www.forbes.com/sites/lanabandoim/2019/12/20/what-the-fdas-decision-about-soy-leghemoglobin-means-for-impossible-burger/?sh=6e0659b057f6>

¹⁸ Fraser R et al. Safety Evaluation of Soy Leghemoglobin Protein Preparation Derived From *Pichia pastoris*, Intended for Use as a Flavor Catalyst in Plant-Based Meat. International journal of toxicology, 37(3), 241–262 [Internet] 2018. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5813221/>

¹⁹ Safety evaluation of a lipase enzyme preparation, expressed in *Pichia pastoris*, intended for use in the degumming of edible vegetable oil. Regulatory Toxicology and Pharmacology.45(1):1-8 [Internet] 2006. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/16563586>

produced through genetic engineering (GE) or genetic modification (GM).

GM soybeans are abundant in global commodity markets, causing some to believe that these foods appear as an ingredient in imported or domestic plant-based meat products in our region. No plant-based meat manufacturers with products sold in Australia and New Zealand currently use GM soybeans as ingredients in their products.

If ingredients produced with GE/GM technologies are used in a food product in Australia and New Zealand, FSANZ requires them to be labelled as such on product ingredient lists. Impossible Foods will be the first brand to introduce a product containing such an ingredient in this market.



This resource provides general information only.

Please contact the team at info@foodfrontier.org for more information.