FERMOTEIN®

The science behind our Whole Food Mycelium ingredient

Nutritional composition, mechanisms of action, and the published evidence base.
Prepared by The Protein Brewery's Nutritional Excellence team.

A technical reference for Science Directors, Formulators, and Brands

Prepared by The Protein Brewery BV · Breda, the Netherlands · Updated May 2026

1. Why fungi?

Fungi are the largest untapped nutritional kingdom on the planet. There are an estimated 2 to 4 million fungal species, of which around 2,000 are known to be edible and fewer than 10 are cultivated at scale. By comparison, just 15 plant crops supply roughly 90 percent of global calorie intake. The opportunity for nutritional breakthroughs resides within fungi.

Meat-like nutrition

Fungi sit closer to animals than to plants on the tree of life. That biology shows up in their nutritional composition: a complete amino acid profile and a phospholipid-rich lipid fraction reminiscent of dairy. For formulators building hybrid products, this removes the usual need to blend two or three plant proteins to close lysine, methionine, or cysteine gaps.

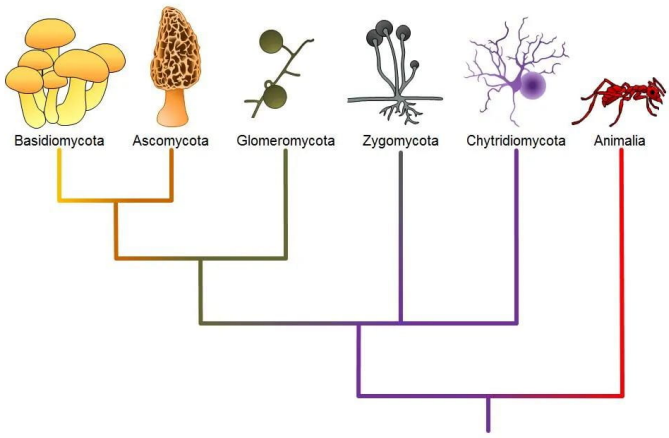
A whole food matrix

Every fungal cell delivers protein, fiber, and lipids together with vitamins, minerals, and naturally occurring bioactives. Structure and nutrition are integrated in a single biomass rather than reconstituted from isolated fractions.

Sustainable by nature

Filamentous fungi convert simple sugars into balanced nutrition and fix inorganic nitrogen into amino acids essential for humans. Biomass fermentation runs on mainstream carbohydrate feedstocks (e.g. glucose) in continuous, energy-efficient processes, with relatively simple downstream handling (e.g. milling).

> *Fungi are closer to animals than to plants on the tree of life. That biology shows up on the nutrition label: complete amino acids, prebiotic fibers, phospholipid rich lipids, and a whole-food matrix that includes naturally occurring bioactives.*



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2. Why *Rhizomucor pusillus* (Fermotein®)?

Fermotein® is the first food-grade biomass powder produced from the mycelium of *Rhizomucor pusillus*. The strain was selected from >1,000,000 screened candidates because it combines three properties that rarely occur together: a uniquely nutrient-dense profile, a neutral sensory profile, and robust performance in large-scale, non-sterile fermentation.

Mycelium, not fruiting body

R. pusillus is a nonfruiting species; only its mycelial network is grown. This is the same biological structure that underpins traditional Asian fermentations such as tempeh and tofu, which means consumers are not encountering an unfamiliar category.

Scalable

The strain is an extremophile that grows quickly under conditions that suppress contaminants, which is what makes continuous fermentation at industrial scale practical and cost-efficient.

Sustainable

1 kg of Fermotein® requires 3 kg of glucose. By contrast, producing 1 kg of whey protein isolate requires ~145 kg of milk (~130 L) with all the upstream impacts of land, feed, water, and emissions.

Naturally safe

Like the wider Zygomycetes/Mucormycota family to which it belongs, *R. pusillus* is genetically unable to produce mycotoxins. Genome analyses, secondary metabolite screens, mycotoxin assays, and i*n silico* investigations for virulence factors, protein toxins, and antimicrobial resistance determinants have all returned negative results. The safety package supporting Fermotein® is published in the peer-reviewed literature.[20,21,22,23,24]

Regulatory status

The EFSA scientific safety opinion on Fermotein® has been completed in December 2025. European Commission authorisation is pending and anticipated Q3 2026.

> *Fermotein® is the first food-grade R. pusillus mycelium. This proprietary strain combines nutrient density, neutral sensory, and scalable non-sterile fermentation — a combination rarely achieved together.*

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3. Nutritional highlights

Fermotein® is a whole-food mycelium with a distinctive 'sum of the parts' profile: 50% protein, 30% fibers, and a bioactive matrix headlined by spermidine. The composition is what makes the ingredient credible across conversations in **longevity, gut health, muscle health, and metabolic health** — few ingredients deliver this density of protein and fiber together.

Headline composition

- **50% protein, PDCAAS 1.0 with all essential amino acids.** Validated against the INFOGEST in-vitro digestion protocol.
- **30% dietary fiber.** Predominantly chitin and chitosan, with smaller amounts of beta-glucan, mucuric acid, and mucoran.
- **Highest spermidine concentration in any natural whole food.** ~1,600 mg/kg — roughly 7-10x more than wheat germ, the best-known food source.
- **Favourable fatty acid profile.** Low total fat (around 5%), but predominantly monounsaturated (oleic acid, the olive oil fatty acid) and polyunsaturated fatty acids (linoleic acid). The phospholipid content is ~3%.
- **Rich in micronutrients.** Notably choline (vitamin B4), important for fat metabolism and a nutrient of concern for plant-forward diets; plus vitamin B6, calcium, iron, zinc, phosphorus, and magnesium.
- **Low in sugar and carbohydrates.**

Compositional summary (per 100 g)

Component	Amount
Crude protein	52 g
Total dietary fiber	30 g
Total fat	5 g
Total digestible carbohydrates	1.5 g
Total sugars	< 0.5 g
Spermidine	1,600 mg/kg
Energy	1,335 kJ / 319 kcal

Source: Fermotein® specification SPE-S-07 (v1.0).

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Amino acid profile (g/100 g)

Essential amino acids in bold.

Amino acid	g/100 g	Amino acid	g/100 g
Alanine	2.3	**Lysine**	**2.9**
Arginine	2.3	**Methionine**	**0.8**
Aspartic acid	4.0	**Phenylalanine**	**1.7**
Cystein	0.5	Proline	1.5
Glutamic acid	4.8	Serine	2.1
Glycine	1.7	**Threonine**	**2.1**
Histidine	**0.8**	Tyrosine	1.6
Isoleucine	**1.7**	**Valine**	**1.9**
Leucine	**3.1**	Tryptophan	0.6
Total	36.6		

Vitamins and minerals (mg/kg)

Vitamins	mg/kg	Minerals	mg/kg
B2 (Riboflavin)	1.7	Calcium (Ca)	1,4
B4 (Choline)	5.0	Magnesium (Mg)	1,6
B6 (Pyridoxine)	3.5	Phosphorus (P)	13,2
		Zinc (Zn)	54
		Iron (Fe)	31

Fatty acid profile (% of total fatty acids)

Class	%
Saturated fatty acids	21
Mono-unsaturated (MUFA, oleic)	50
Poly-unsaturated (PUFA, linoleic)	28
Trans fatty acids	0.7

Source: Fermotein® specification SPE-S-07 (v1.0).

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4. The science behind cellular health support

Mechanism

Fermotein® is a rich natural food source of spermidine. Spermidine can trigger autophagy — the cellular cleanup process that won the 2016 Nobel Prize in Physiology or Medicine — via a pathway linked to mTOR inhibition, similar to that of caloric restriction. Preclinical research indicates that spermidine supports the breakdown of damaged organelles, misfolded proteins, and intracellular pathogens, with downstream effects on mitochondrial function and protein synthesis.[3,4]

> *"In humans, spermidine levels decline with aging. An increased uptake of this polyamine with spermidine-rich food diminishes overall mortality associated with cardiovascular diseases and cancer."*
>
> — Ni & Liu (2021), Aging and Disease

Human evidence

- **Memory and dementia.** Spermidine supplementation at 3.3 mg/day produced a statistically significant positive effect on memory performance in older adults suffering from dementia in a three-month trial, with effects sustained over one year of follow-up.[8,9]
- **Safety in healthy older adults.** Spermidine is safe and well-tolerated in healthy older men at intakes of 40 mg/day.
- **Mortality and cardiovascular risk.** Higher dietary spermidine intake is associated with lower all-cause and mortality related to cardiovascular disease in two large population studies.[6,7]
- **Inflammation.** A polyamine-rich diet elevates blood spermine levels and inhibits proinflammatory status in an interventional study.[5]

Ongoing studies

- **Cardiovascular and inflammation endpoints.** Study of spermidine at 24 mg/day on exercise capacity, muscle mass, and inflammation in elderly patients with coronary artery disease.
- **Cognition and sleep.** Ongoing 12-week study of spermidine at 6 mg/day on cognitive impairment and sleep.

Planned studies on Fermotein®

- **Human clinical study.** Spermidine and spermine levels in blood of adults with glucose intolerance after consumption of a single dose of Fermotein® (0-21-24 gram) alongside glucose, insulin, and GLP-1 response. Results are expected early 2027.

- Spermidine and spermine levels in blood of healthy adults after consumption of 11-gram Fermotein® for 18 days. Results are expected by the end of Q3 2026.

Preclinical longevity model. Lifespan study in *C. elegans* with 7 mg synthetic spermidine or an equivalent dose of spermidine from Fermotein®. C elegans is the gold-standard model organism for longevity research. Results are expected by the end of Q3 2026.

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6. The science behind GUT HEALTH support

Approximately 30% of Fermotein® is dietary fiber, dominated by chitosan and chitin (each 10%), with smaller contributions from beta-glucan, mucuronic acid, and mucoran. Chitosan is an insoluble fiber found naturally in fungal and crustacean cell walls but absent from plants. *Fungal chitosan has a lower molecular weight than marine-sourced chitosan*, which is mechanistically relevant for its physiological effects.

Microbiota modulation: Alpha-diversity

In a preclinical in-vitro fermentation model using a pooled human faecal sample, Fermotein® increased microbial alpha-diversity (Shannon index) versus the blank control. Inulin, a well-characterised reference prebiotic, decreased alpha-diversity in the same system. Higher alpha-diversity reflects a more resilient, metabolically versatile gut ecosystem that better supports barrier function, immune balance, and recovery from perturbation.

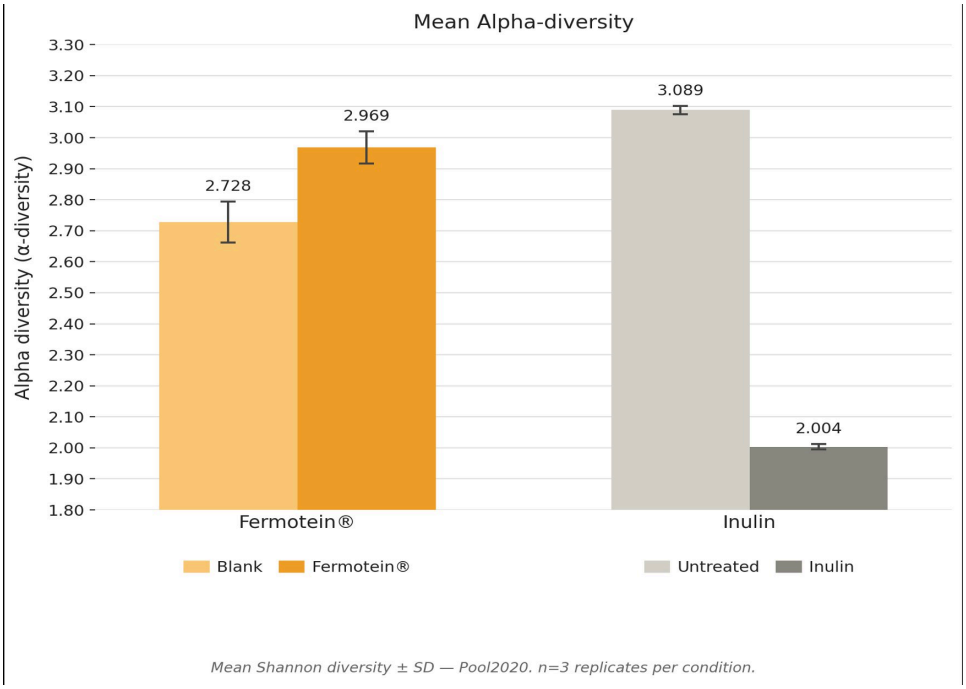

Figure 2. Mean Shannon diversity ± SD measured at 24 h in an in vitro fermentation model. Pool2020, n = 3 replicates per condition. Fermotein® increased diversity versus blank; inulin reduced it.

Short-chain fatty acid production

Fermotein® increased production of all three principal short-chain fatty acids (SCFAs) versus a blank control in the same model: butyric acid +41%, propionic acid +55%, and acetic acid +37%. SCFAs are microbial metabolites that play central roles in gut barrier function, immune regulation, and metabolic control. Preclinical research has also shown that some Bacteroides species — which can

ferment dietary fibers, produce SCFAs, and produce polyamines such as spermidine — increased upon treatment with Fermotein®.

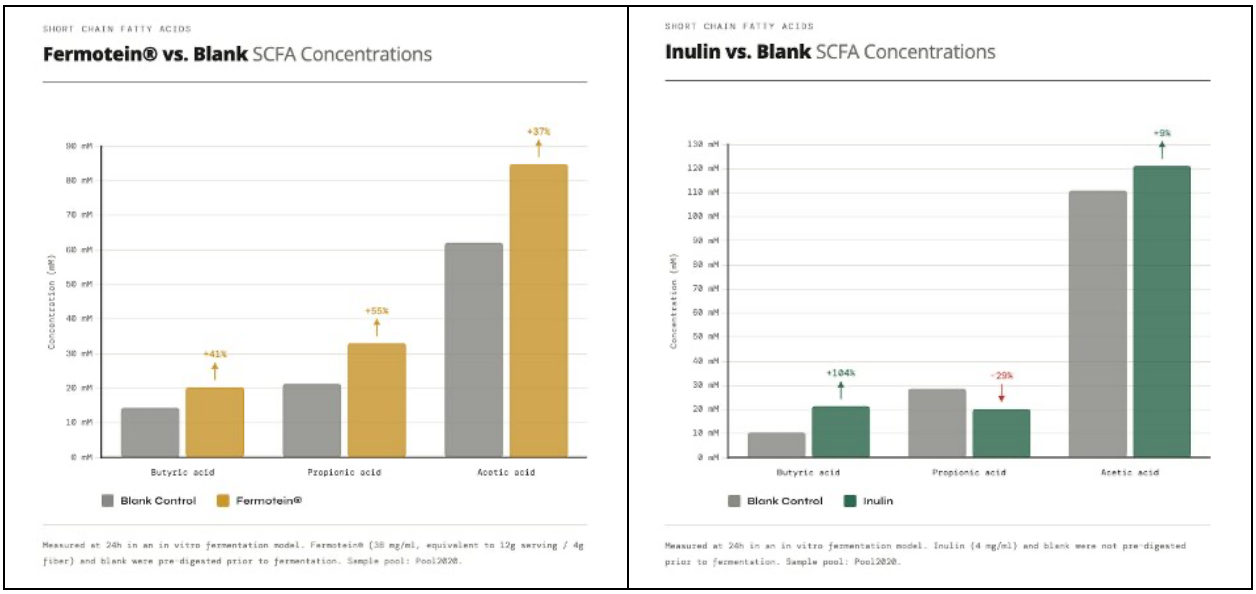

Figure 3. SCFA concentrations at 24 h in an in vitro fermentation model. Fermotein® (left, at 50 mg/mL, equivalent to a 12 g serving providing roughly 4 g fiber, pre-digested before fermentation) versus inulin reference (right, 4 mg/mL). Sample pool: Pool2020.

Cholesterol

Low-molecular-weight chitosan has been shown to reduce total cholesterol when consumed with meals across populations with normal, borderline-high, and high baseline cholesterol.[10,11,12] A four-week dietary intervention with mycoprotein-containing foods has also been shown to reduce serum cholesterol concentrations in community-dwelling, overweight adults.[13] As Fermotein® is rich in chitosan, it is a strong candidate for the maintenance of healthy cholesterol levels.

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6. The science behind METABOLIC HEALTH support

Why GLP-1 matters for nutrition

Glucagon-like peptide-1 (GLP-1) is a satiety hormone released from intestinal cells in response to meal ingestion. GLP-1 receptor agonists and enhancers have reshaped the weight-management landscape, and millions of consumers are now seeking natural support for the same biology.

Human and animal studies have shown that dietary proteins are potent stimulators of GLP-1 secretion.[16] Monosaccharides, mono- and polyunsaturated fatty acids, and short-chain fatty acids also modulate GLP-1 secretion.[17] In a one-year human study, high wheat-fiber cereal increased SCFA production and GLP-1 secretion in hyperinsulinaemic volunteers.[18]

Fermotein® and GLP-1: the evidence to date

Fermotein®'s composition — complete protein, fiber, MUFA/PUFA-rich lipids, and low sugar and saturated fat — hits multiple known levers of GLP-1 secretion in a single ingredient. An original preclinical ex-vivo study using human intestinal segments indicates that Fermotein® increases GLP-1 secretion, supporting its role as a candidate natural GLP-1 inducer.

> *A double-blind, randomised, crossover clinical trial at Wageningen Food and Biobased Research is in progress to assess the effects of Fermotein® on glycaemic index (blood glucose and insulin) and GLP-1 levels in human volunteers.*

Companion nutrition for GLP-1 users

Beyond its potential as a natural GLP-1 booster, Fermotein® is well-suited as a companion product during GLP-1 drug therapy. The high-quality protein supports the maintenance of muscle mass during rapid weight loss that often accompanies GLP-1 use, while the fiber fraction may help mitigate the gastrointestinal discomfort frequently reported by patients. Choline, B6, calcium, iron, zinc, phosphorus, and magnesium contribute to nutrient coverage that is otherwise difficult to maintain at reduced caloric intake.

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7. The science behind MUSCLE HEALTH support

The problem

Muscle mass declines at roughly 3–8% per decade after age 30, with the rate of decline accelerating after age 60.[19] Sarcopenia is a well-established risk factor for reduced mobility and independence, which makes muscle maintenance one of the central questions in active aging.

Why protein quality matters more than quantity

In older adults, anabolic resistance means that protein utilisation declines with age. Incomplete or poorly digestible proteins require higher intakes to achieve the same physiological effect. A PDCAAS of 1.0 and a complete amino acid profile is therefore a critical benchmark.

Fermotein® evidence

- **Complete amino acid profile.** Fermotein® contains all amino acids including all essential amino acids.
- **PDCAAS 1.0.** Validated using the INFOGEST in-vitro digestion protocol; Fermotein® is well digested and delivers all amino acids without being an isolate or concentrate.
- **Mycoprotein and muscle protein synthesis.** Mycoprotein ingestion has been shown to stimulate muscle protein synthesis to a greater extent than milk protein in rested and exercised skeletal muscle of healthy young men in a randomised controlled trial.[14]
- **Spermidine and muscle.** Preclinical research indicates that spermidine can play a role in muscle protein synthesis and supports mitochondrial function relevant to performance and recovery.[3]
- **Micronutrient coverage.** Calcium and magnesium contribute to normal muscle function; vitamin B6 and magnesium contribute to the reduction of tiredness and fatigue; vitamin B6, iron, phosphorous, and calcium contribute to normal energy-yielding metabolism (EU Regulation 432/2012).[1]

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8. The Fermotein® longevity pyramid

Fermotein® and the body at a systems level.

Rather than targeting a single mechanism, Fermotein® could fortify the foundational systems that compound into healthier years: cellular maintenance and cognition at the apex, with foundations linked to gut health, muscle health, and metabolic health. The cellular hallmarks of ageing, including (disabled) autophagy, underpin the pyramid.

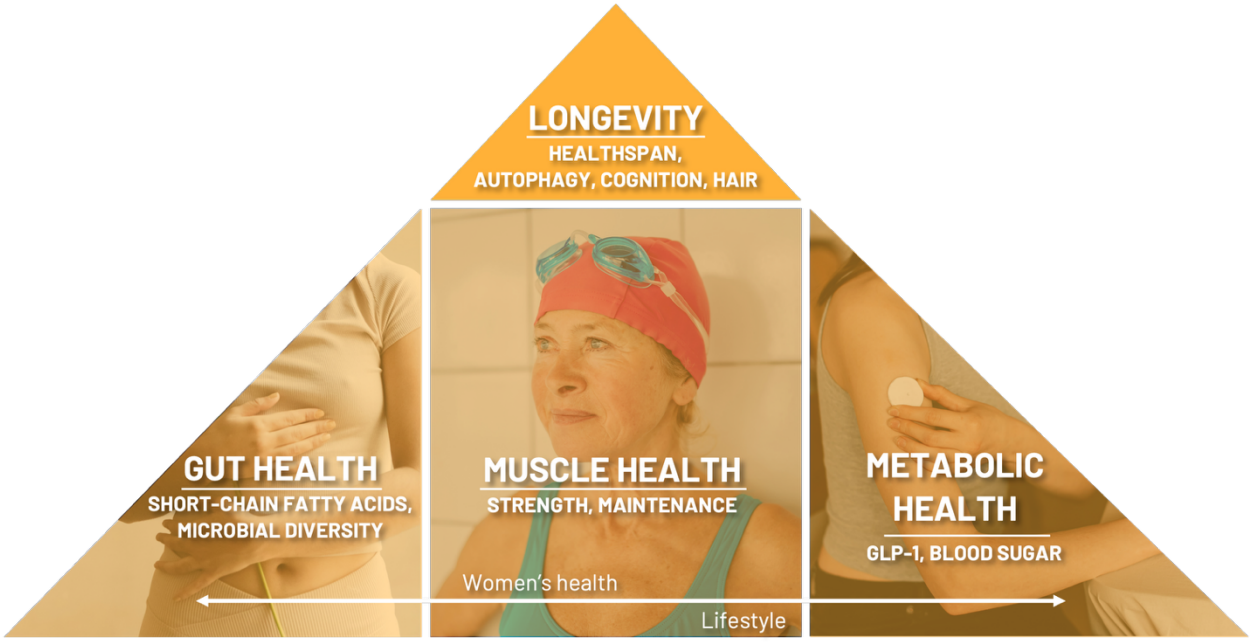

Figure 1. The Fermotein® longevity pyramid.
Longevity (healthspan, autophagy, cognition, hair) supported by gut health, muscle health, and metabolic health.

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9. Summary for technical evaluation

Fermotein® is a single, minimally processed mycelium powder that delivers complete protein (all amino acids), dietary fiber (predominantly chitin and chitosan), favourable lipids, low sugar and low carbohydrates, a broad micronutrient profile, and the highest spermidine concentration of any natural whole food.

Its evidence base spans published safety, regulatory submission, in-vitro and ex-vivo mechanistic work, and clinical research that is either ongoing or planned.

For Science and R&D teams evaluating the ingredient, the practical implication is that Fermotein® simplifies formulation. A protein and fiber system, a spermidine source, a GLP-1 stimulant, and a nutrient-dense matrix can be addressed with one input rather than four – reducing compounding complexity and shelf-life risk in food and liquid systems.

> *For technical samples, application trials, supporting study reports, or to discuss a specific formulation challenge, contact our sales team:*
>
> **Thijs Bosch** | thijsbosch@theproteinbrewery.com
> **Roel van de Put** | roelvandeput@theproteinbrewery.com
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> *We collaborate closely with customer teams from concept through MVP and into market.*

Scientific bibliography

References are organised by topic and citation number used in the body of this document.

Hyperlinks point to the primary source where available.

Original studies commissioned by The Protein Brewery are available upon request.

Regulatory framework

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