



solein

# SOLEIN® PROTEIN OUT OF THIN AIR

An introduction to an alternative protein that  
will change the way you think about food.

# YOUR EVERYDAY REVOLUTION.

A revolution is needed in the way we produce and consume protein. The ecosystems of the planet can't keep up with humanity's desire for meat, eggs, dairy, soy and all the other conventional sources of protein.

Thankfully, there is an alternative.

Solein® aims to be the first food on the market that is produced without agriculture and without fossil fuels. As a protein source, Solein's comparative greenhouse gas emissions are approximately 1% that of meat protein and about 20% of plant protein production. Compared to them, it also takes just a fraction of the amount of water to produce Solein. The energy used in the process comes from renewable resources.

Solein is a novel food, meaning it is food never made available for commercial use before. Growing and harvesting single cells from nature for food was not possible for hunter-gatherers 100,000 years ago, or the human race in general up until today. We have now reaped the first harvest of this new food and it's called Solein.



# WHAT IS SOLEIN?

The diversity of nature is more varied than meets the eye. Solein has been around in nature even longer than our other foods have. Solein is protein in its most natural form. It is not a plant nor an animal. Instead, it originates from a non-modified, single-cell organism. It is not artificial, but a completely natural protein, even though it is not grown traditionally from the earth. We just haven't seen it on our plates before.

The original single-cell microorganisms for Solein were collected from Finnish nature. The microbes were cultured and grown with air and electricity as its primary resources in a fermentor akin to the ones used in breweries and wineries.





# MAKING SOLEIN

The Solein microbes are put in a liquid – called a growth medium – within a fermentor. The liquid is continuously supplied with small bubbles of hydrogen, oxygen and carbon dioxide, as well as some nutrients including nitrogen, calcium, phosphorus and potassium, which are the same nutrients that plants normally absorb through their roots from the soil. The microbes eat these ingredients to grow and multiply.

As the liquid grows thicker, some of the slurry is continuously removed and dried. The resulting dried powder is Solein, which is made up of whole cells that are 65–70% protein, carbohydrates and fats. The macronutrient composition of the cells is very similar to that of dried soy or algae.



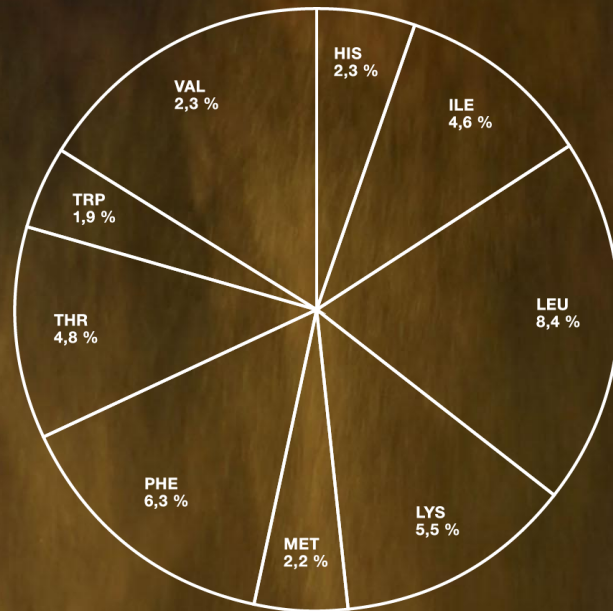
# WHY IS PROTEIN IMPORTANT?

Protein is a basic constituent in all living organisms: it makes us what we are and keeps us that way. Protein is found in muscle, bone skin, hair, and every other tissue. It is an integral macronutrient for the human body, where it plays an essential role both functionally and structurally. Different proteins are necessary for our enzymatic activity, immunity, cell signalling, and muscle work. They are involved in repair and transport processes to form the building blocks for several cellular structural elements.

# SOLEIN CONTAINS ALL OF THE NINE ESSENTIAL AMINO ACIDS

Protein is constructed from building blocks called amino acids. In nature, there are hundreds of amino acids but only 20 of these are used to build proteins in a living organism. Nine amino acids, known as the essential amino acids, must come from food because those cannot be made by the body. Animal-based protein as well as soy and algae protein are often called complete proteins, as they contain all nine essential amino acids in adequate proportion.

Despite being grown with resources from air, Solein is a complete protein, containing all of the nine essential amino acids.



Solein contains all the amino acids essential to the human diet.



# EATING SOLEIN

## The taste of Solein

Solein has hardly any taste. Our professional product development characterises its taste as “neutral”, which means it does not bring any distinctive taste to the final product. This is good news as many of the alternative proteins in the market have a strong taste with off-notes, which needs to be masked in the final food products to cover the taste.

Since the taste of Solein doesn't affect the final taste of the foods, it vanishes into foods easily making Solein ideal for virtually every food imaginable, sweet or savoury. In our view having access to an alternative natural protein shouldn't require you to sacrifice your choices, or taste buds, as a consumer.

## Where does the colour come from?

The yellow colour comes from beta-carotene, which is a naturally occurring pigment in Solein. Carotenoids are antioxidants and a great nutrient. An example of a familiar source of carotenoids is carrots. The yellow colour does not affect the taste though.



Dietarily, Solein is kind to all. It's 100% vegan, gluten-free, dairy-free, soy-free and it does not contradict any religious dietary restrictions.

# FOODS

The adaptability of Solein is virtually limitless.

Solein can be used as a protein ingredient in existing foods such as bread, pasta and plant-based dairy, drinks, and in between meals.

Secondly, Solein can be used as a protein ingredient in alternative meat and dairy products.

Thirdly, if laboratory-grown meat production will scale up in the future, Solein could provide the amino acid platform that real meat cells could use for growing.

## Examples of foods that Solein is great for:

- Meat alternatives
- Cereal and bakery
- Snacks
- Beverages
- Spreads and toppings
- Noodles and pasta
- Dairy alternatives





# SOLEIN FUNCTIONS IN FOODS

**As an ingredient, Solein has unique features:**

- A complete protein with all the essential amino acids
- Pleasant smooth texture and mouthfeel
- Suitable mild umami taste for sweet and savoury products
- Does not alter the taste of products
- Optimal for developing rich flavour profiles
- Authentic meaty and juicy texture resembling real muscle meat





**MEAT ALTERNATIVES**



**CEREALS AND BAKERY**



**SNACKS**



**BEVERAGES**

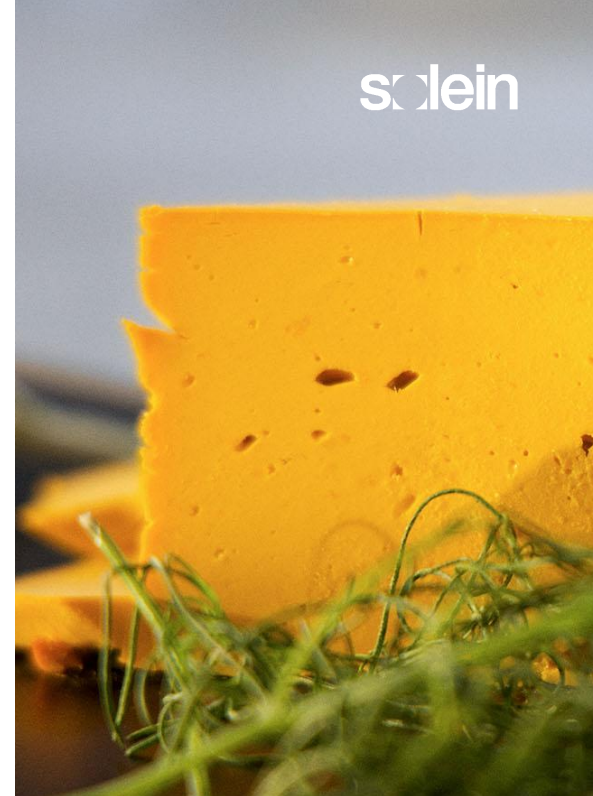




**SPREADS AND TOPPINGS**



**NOODLES AND PASTA**



**DAIRY ALTERNATIVES**

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# SOLEIN BENEFITS IN FOOD APPLICATIONS

- Natural and sustainable
- Improves the nutritional value of existing products
- High in iron
- Rich in B vitamins, good for vegan and vegetarian diets
- Beta-carotene pre-cursor to vitamin A
- Natural sunny yellow in colour due to beta-carotene
- Low in sodium and fat
- Vegan
- Non-dairy
- Non-GMO
- Soy- and gluten-free
- No religious dietary restrictions



# NUTRITIONAL VALUES

## Nutritional profile

Solein is an extremely diverse ingredient. Solein contains all the essential amino acids, carbohydrates, fats and minerals as any other food. Solein is very high in protein – up to 70%. It's high in iron and fibre and rich in B-vitamins and antioxidants.

## The nutritional profile consists of

- Protein 65–70 %
- Fat 5–8 %
- Dietary fibres 10–15 %
- Minerals 3–5 %





# NUTRITIONAL VALUES

## Chemical composition

Solein cells, like all other living material on the planet earth, are comprised of carbon (46% of weight in Solein), hydrogen (6.5%), oxygen (25%) and nitrogen (12%).

Also, Solein production requires some minerals to provide elements, such as sulfur, calcium, iron, phosphorus, magnesium, manganese, zinc, potassium, and sodium – in total, approximately 20 elements that are essential to life.

These are elements that plant roots would absorb from the soil. In a full air-capture concept for Solein production, C, H, O, and N are all sourced from the air, while nutrient minerals still need to be sourced from added nutrients.



# SOLEIN'S FOOTPRINT

Solein's biggest footprint comes from electricity, which is used to split water into hydrogen and oxygen to feed the microorganisms.

With the best available technology, the efficiency from electricity to calories is about 20%.

Solein is 100 times more efficient in converting energy to calories than animals. And compared to plants, by hectare, the yield in Solein is 10 times more than photosynthetic plants – even if the electricity for Solein production would be from solar panels (which requires a decent amount of square mileage).

Theoretically speaking, looking at our home country of Finland, if all the calories that Finns consume would be from Solein, the whole food production of a nation would require 10% of the primary energy use of Finland and one-third of the electricity consumed today.



# THE WORLD AFTER SOLEIN

Based on scientific evidence Solein is the most environmentally friendly protein. If it would replace meat in the human diet, the crises of the planetary ecosystem and the climate would be gone.

Solein production does not require arable land and it is very efficient in water use, therefore it can provide nutrition for water-scarce areas and areas bereft of agricultural land and suitable farming conditions. It could be farmed on Antarctica or in the Sahara paving the way to resolving global environmental problems and hunger.

Solein also binds carbon from the air, because the microbes feed on it. 1 kg of Solein takes up 1.85kg of CO<sub>2</sub>.

Environmental problems, as well as famines, are due to economic failures and lack of technological knowledge.

People are willing to change their consumption habits if there is a real alternative that is affordable, tastes good, is nutritious and empowers you to make the right choices. We have the technological platform to make one of the biggest impacts to the planet, revolutionising the way we produce and consume food.

We call it Solein.





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# SOLEIN IS REAL BUT NOT YET FOR SALE.

We aim to be on the market in 2023.

We are growing quickly though. Solar Foods has scaled up production 100x from pilot to commercial demo. And another 100x scaleup is underway to move from demo to factory.

If you want to know more about the technology, our process, or our business roadmap, then check out our company page: [solarfoods.fi](https://solarfoods.fi)

You can also stay up to date by joining our mailing list, where we cover the latest progress of Solein and look at the landscape and future of global food production.



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# CONTACT US AT SOLAR FOODS TO FIND OUT MORE.

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