

# MEAT LAB GROWN and PLANT-BASED PROTEIN VOL 2

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richer source of protein than beef, fish**



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Scientists in Germany have developed a method to obtain protein and vitamin B9 from microbes by providing them with little more than hydrogen, oxygen, and carbon dioxide.

Powered by renewable energy, this technology produces a sustainable, nutrient-rich protein substitute that could eventually become a part of our daily diets.

"This is a fermentation process similar to how you make beer, but instead of giving the microbes sugar, we gave them gas and acetate," says author Lergus Angenent of the University of Tübingen, Germany.

"We knew that yeast could produce vitamin B9 on their own with sugar, however, we didn't know if they could do the same with acetate."

## Yeast, hydrogen, carbon dioxide: A winning combo

The researchers developed a bioreactor system with two stages that creates protein- and vitamin B9-rich yeast. In the first stage, a bacterium called *Thermoanaerobacter kivui* converts hydrogen and carbon dioxide into acetate, a compound also found in vinegar.

In the second stage, *Saccharomyces cerevisiae* (commonly known as baker's yeast) consumes the acetate and oxygen to generate both protein and vitamin B9. The hydrogen and oxygen needed for this process can be obtained by splitting water using electricity from renewable sources like wind energy.

Interestingly, yeast fed with acetate produces roughly the same amount of vitamin B9 as yeast that relies on sugar. A small portion—just 6 grams or 0.4 tablespoons of dried yeast—provides enough vitamin B9 to meet the daily recommended intake.

"We are approaching 10 billion people in the world, and with climate change and limited land resources, producing enough food will become harder and harder," says Angenent.

"One alternative is growing proteins in bioreactors through biotechnology rather than growing crops to feed animals. It makes agriculture much more efficient."

## Surpassing animal-derived protein

The researchers discovered that the protein content in their yeast surpasses that of common sources like beef, pork, fish, and lentils. A serving of 85 grams, or about 6 tablespoons, provides 61% of daily protein needs. In comparison, beef supplies 34%, pork 25%, and both fish and lentils provide 38%.

However, before consumption, the yeast needs treatment to remove compounds that could raise the risk of gout if eaten in large amounts. Even after treatment, the yeast still delivers 41% of the daily protein requirement, making it a competitive alternative to traditional protein sources.

This innovative technology tackles critical global issues such as environmental sustainability, food security, and public health. The system significantly reduces [carbon emissions](#) associated with food production by using renewable energy and carbon dioxide.

It also breaks the dependence on land for farming, creating opportunities for land conservation. The lead researcher, Angenent, emphasizes that the goal isn't to replace farmers but to encourage the sustainable production of vegetables and crops. The team's [yeast](#) could also be a valuable tool in combating food shortages and nutrient deficiencies, particularly in developing countries.

## Next steps

However, before you can expect to see the team's [yeast](#) on grocery shelves as a protein alternative, lead researcher Angenent notes that there's still significant work ahead. The team plans to refine and expand production, ensure food safety, perform technical and economic evaluations, and assess consumer demand in the marketplace.

"The fact that we can make vitamins and [protein](#) at the same time at a pretty high production rate without using any land is exciting," says Angenent. "The end product is vegetarian/vegan, non-GMO, and sustainable, which could appeal to consumers."

The study has been published in Cell Press's journal [Trends in Biotechnology](#).



What you eat can, and does, impact the function of your brain, including your ability to [ward off Alzheimer's disease](#) and there are certain foods — like sunflower seeds and whole grains — that provide greater benefits.

There is one food in particular that [Dr. Uma Naidoo](#), a Harvard nutritionist, and [Lisa Genova](#), a Harvard-trained neuroscientist, say is the key to a healthy brain: Green leafy vegetables.

***[DON'T MISS: 5 doctors and nutritionists share the foods they eat every day for brain health, longevity and overall wellness](#)***

### **The No. 1 food for a healthy brain: Green leafy vegetables**

Across the board, experts agree that eating leafy greens is essential for overall health, especially for your brain.

Some of the green leafy vegetables that you can add to your meals are:

- Kale
- Spinach

- Lettuces
- Cabbage
- Swiss chard
- Bok choy
- Mustard greens

### **3 reasons experts say a diet rich in leafy greens is good for your brain**

## 1. They're rich in B vitamins

Often, conditions like depression and dementia are associated with a vitamin B deficiency, according to [a study from the Wayne State University School of Medicine](#).

Green leafy vegetables are a wonderful source of vitamin B9, [Naidoo told CNBC Make It](#) in 2022. The vitamin, also known as [folate](#), is "a key vitamin for supporting brain and neurological health, optimal neurotransmitter function, and balanced psychological health," she added.

Leafy greens are the first type of food that Naidoo suggests for her patients who are looking to boost their mood.

## 2. They're high in brain-boosting nutrients

Green leafy vegetables are also full of what [Genova calls "brain-boosting nutrients"](#) including folate, lutein and beta-carotene.

Lutein has been [linked to an improvement in brain function](#) and brain structure for older adults. And a [systematic review](#) found that taking beta-carotene supplements can boost "verbal and cognitive memory."



### 3. They're full of fiber

Increasing intake of dietary fiber was associated with a lower chance of developing depression, a [study](#) published in "Complementary Therapies in Medicine" in 2021 found.

Naidoo prefers to recommend [getting more fiber through your diet](#), specifically plant-based foods. And leafy greens just so happen to be fiber-dense.

## The CDC Declared This Vegetable to Be the Healthiest — and it Just May Surprise You

It's also super easy to prepare.



Food & Wine / Getty Images

You have a wide range of vegetables to choose from on a regular basis, but research shows that there's one that's particularly good for you: watercress.

This leafy green has been deemed the healthiest vegetable by the [Centers for Disease Control and Prevention](#) (CDC), with an impressive nutrient density score of 100 out of 100. But watercress isn't just ranked the healthiest vegetable: It beat runner-up Chinese cabbage by more than eight points.

Nutritionists aren't shocked. "I can believe that watercress is the 'healthiest' vegetable," says [Dana Ellis Hunnes, Ph.D.](#), a senior dietitian at UCLA Medical Center and assistant professor at the UCLA Fielding School of Public Health. Among other things, Hunnes points out that this is a "nutrient-dense" food.

Related: [7 Best Watercress Salads](#)

Given that watercress isn't a staple in most American fridges, it's understandable to have questions. Here's why this vegetable is so healthy, plus how to get more of it on your plate.

## What is watercress and what makes it so healthy?

Watercress is a type of cruciferous vegetable that belongs in the same family as kale, broccoli, Chinese cabbage, arugula, and Brussels sprouts, says [Rachel O'Connor, R.D., C.D.N.](#), a dietitian at NewYork-Presbyterian/Columbia University Irving Medical Center. It's also an aquatic flowering plant (hence, the name) and grows in shallow water or damp soil, Hunnes says.

Watercress got top honors thanks to its perfect nutrient density score. "Nutrient density is the ratio of nutrients in a food to the amount of energy — or calories — it provides," O'Connor says. "A nutrient density score is essentially a numeric value given to rate how nutritious certain foods are." The more nutrient-dense a food is, the more vitamins, minerals, and antioxidants it has per calorie per gram, Hunnes explains.

Related: [16 Ways to Enjoy Watercress](#)

Watercress has a few compounds, including 3,3'-diindolylmethane (DIM) and sulforaphane, which have been linked to a lower risk of cancer, O'Connor says. The vegetable is also rich in vitamin K. While watercress contains fiber, the levels of the nutrient aren't as high as they are in some fellow cruciferous vegetables. One cup of cooked broccoli, for example, will provide around [5 grams](#) of fiber, while one cup of watercress provides [less than 1 gram](#). "Fiber is an important component to our diets for numerous reasons, so watercress should definitely not be the only cruciferous vegetable one eats," O'Connor says.

## Do any other vegetables come close?

The CDC's study lists out more than 40 so-called "powerhouse" fruits and vegetables. While watercress was the only one that received a perfect score, the runners-up are also worth noting. Those include:

- Chinese cabbage (91.99 points)
- Swiss chard (89.27 points)
- Beetroot (87.08 points)
- Spinach (86.43 points)

## How much watercress do you need to eat?

It is generally [recommended](#) that you have four to five servings of fruits and vegetables a day, and four to five servings of cruciferous vegetables a week. But you can have watercress as much as you'd like, Hunnes says. "You could eat one cupful at a time," she says. "You could eat it more often or less often, too."

While you can cook watercress, it may be better to have it raw to reap the full benefits. "Watercress, like other vegetables, loses some vitamin C and B vitamins



when cooked,” O’Connor says. “Vitamin C is water-soluble and sensitive to heat, and it can leach out of vegetables when they are exposed to hot water. B vitamins are similarly heat-sensitive.” So, use it as a base for salads, toss it in a sandwich, or sprinkle it on top of a stir fry for added nutrition.

No matter how you prepare it, Hunnes stresses that you should have more than just watercress. “Even if it is the healthiest of all vegetables, it’s still better to eat a wide range of vegetables and fruits than to just stick with one,” she says. “That allows you to get a fuller complement of nutrients.”

**G**etting [10,000 steps a day](#). Improving your [VO2 max](#). Putting [berries on your breakfast](#). What are the habits you embrace in an effort to live a long, healthy life? Certainly it’s the routines/rituals we do regularly that impact our health the most.

But there’s one well-intentioned habit in particular that longevity experts say can actually take years off your life instead of adding more to it: eating too much animal-based protein. Thought a high-protein diet was a good thing? As doctors explain here, getting too much can backfire.

## **Why Overemphasizing Protein Isn’t Actually Healthy**

Before we get into why too much protein isn’t good for longevity, it’s important to note that the nutrient is absolutely important. [Dr. Suzanne J. Ferree](#), who is double-board-certified in family medicine and anti-aging and regenerative medicine, told HuffPost that it’s especially important to get enough as we age.

“The common theory is that we need to cut protein-rich foods as we age, but the research actually only supports this in younger people, not in those of us over

50,” Ferree said. [Scientific research backs this up](#), showing that older adults need more protein than younger adults because our bodies naturally lose muscle as we age.

So yes, protein is absolutely important. [How much protein a person needs each day](#) varies based on one’s individual health and needs, but the Food and Drug Administration recommends aiming for 50 grams of protein a day as part of a 2,000-calorie diet. The problem is that many people are eating more protein than they need. On top of that, Americans are overconsuming a specific type of protein that isn’t all that healthy.



"Excessive consumption of animal-based proteins can actually accelerate aging and undermine cellular health, contrary to popular belief," said Dr. Monisha Bhanote.

In general, there are two types of proteins: animal-based proteins and plant-based proteins. [Research has shown](#) that plant-based proteins are healthier than animal-based proteins. Unfortunately, Americans are consuming more of the latter than the former.

"A common mistake is the overemphasis on consuming a high-protein diet, particularly one rich in animal-based proteins, with the belief that it is essential for longevity and muscle preservation. Many people assume that the more protein they consume, the healthier they will be, leading to an overconsumption of animal products like meat, dairy and eggs," said [Dr. Monisha Bhanote](#), a quintuple-board-certified physician and longevity expert.

Most Americans are eating [about 100 grams](#) of protein a day, double the recommended amount. [According to a Dietary Guidelines for Americans report](#), 75% of Americans meet or exceed the recommendation for meat, poultry and eggs. Bhanote says this is exactly what can take years off one's life.

"Excessive consumption of animal-based proteins can actually accelerate aging and undermine cellular health, contrary to popular belief," she said. She explained that the biggest reasons for this come down to two harmful compounds: advanced glycation end products (AGEs) and trimethylamine N-oxide (TMAO).

"AGEs are harmful compounds that form when proteins or fats combine with sugar in the bloodstream," Bhanote said. She explained that animal-based foods — especially if they are grilled, fried or roasted — are high in AGEs. [Research shows](#) that these compounds can accumulate in your tissues and, over time, can lead to oxidative stress and inflammation, which are key drivers of cellular aging. "AGEs damage proteins, DNA and other vital cellular structures, accelerating the aging process and contributing to chronic diseases like diabetes, cardiovascular disease and Alzheimer's," Bhanote said.



Plant-based proteins are

What about TMAO? Bhanote explained that elevated levels of [TMAO](#) have been linked to an increased risk of cardiovascular diseases, including atherosclerosis, heart attack and stroke — all of which obviously are not good for longevity. “TMAO promotes the accumulation of cholesterol in the arteries and impairs the body’s ability to remove it, leading to inflammation and further damage to the cardiovascular system. This not only compromises heart health but also affects overall cellular function and longevity,” Bhanote said.

Related to the mistake many people make of overemphasizing protein in their diet, [Raghav Sehgal](#), a Ph.D. student and Gruber fellow at Yale University whose research focuses on human aging, told HuffPost that one common mistake people make when it comes to longevity is focusing on “miracle diets” promising fast results. The biggie that’s relevant here: the [ketogenic diet](#), which prioritizes fat and protein while minimizing carbohydrates. For many people doing keto, meat and eggs are hero **foods; however, as previously explained**, eating too many animal products can take years off your life.

# How To Use Protein To Work For You, Not Against You

So, how should we approach protein with an eye toward longevity? Bhanote and Sehgal are of the same mind about this: Eat more protein-rich plants and fish.

While fish certainly isn't a plant, it is thought of differently than animal-based proteins because it has a completely different nutritional makeup than meat, and scientific research has repeatedly shown benefits to human health when consumed regularly. Eating fish regularly has been associated with [reducing the risk of premature death by 12%](#).

Sehgal explained that plant-based proteins (such as beans, lentils, chickpeas, soy, nuts and seeds) are loaded with antioxidants, fiber and nutrients that keep our hearts healthy, reduce inflammation and lower the risk of chronic diseases. "These foods are naturally low in AGEs and do not contribute to TMAO production, making them much gentler on your cells and overall health," Bhanote added.

[Scientific studies show](#) that having a diet that prioritizes plant-based proteins lowers the risk of mortality associated with cardiovascular disease and other causes. In other words, replacing animal proteins with plant proteins can add years to your life.

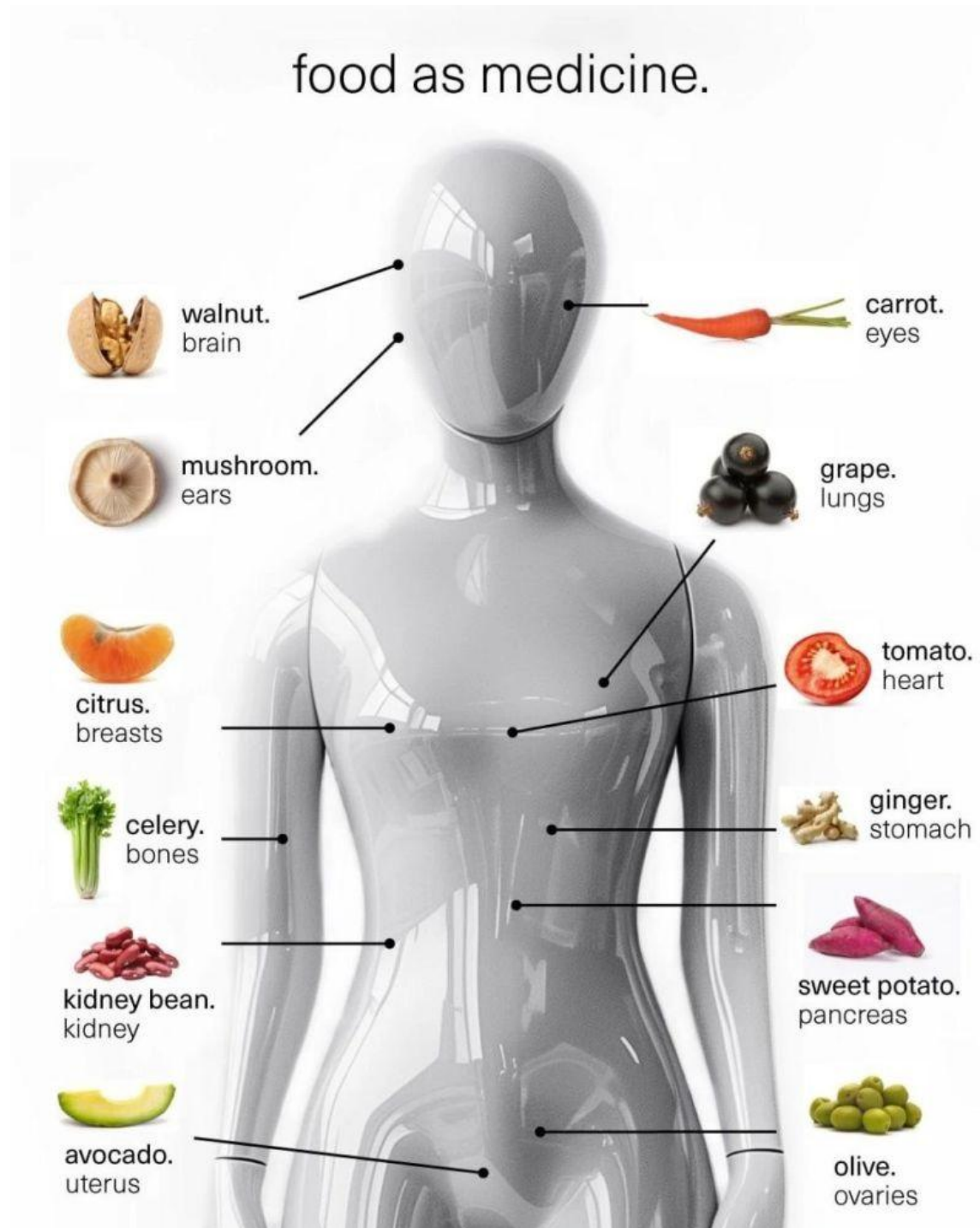
While most Americans meet or exceed the protein recommendation for meat, poultry and eggs, 90% of Americans [aren't meeting the recommended guidelines for seafood](#). Sehgal told HuffPost that seafood high in protein and unsaturated fats supports [brain health](#), promotes [hormone balance](#) and [helps fight inflammation](#)— all of which contribute to longevity.

Again, no one is disputing that protein is important. It's crucial to get enough and, as Ferree pointed out, it's especially important to get enough as we age. But other nutrients are important too, which is why Sehgal said the best diet for longevity is a balanced one that includes a wide variety of nutrient-rich foods.

The benefit of eating a balanced diet full of plants certainly isn't revolutionary news, but it is backed up by many scientific studies. When it comes to longevity — and health in general — science-backed wins out over trendy and new.



These dietitian-recommended choices are tasty, nutritious, affordable and convenient—plus they stay fresh in the pantry.







Photographer: Brie Goldman, Food Stylist: Charlie Worthington

### **Reviewed by Dietitian Emily Lachtrupp, M.S., RD**

It is estimated that 2 in 5 Americans between the ages of 18 and 44 have insulin resistance, a condition where the body's cells don't respond well to insulin, impairing their ability to soak up glucose from the bloodstream. This triggers the pancreas to make more insulin, potentially leading to prediabetes and type 2 diabetes over time.,

The good news is insulin resistance can be [reversible](#) when we adopt positive lifestyle behaviors, such as being active and eating a nutrient-dense and balanced diet. These lifestyle patterns can also decrease the risk of prediabetes.

A balanced diet includes eating a variety of whole grains, veggies, fruits and lean proteins. One category of lean proteins to eat are plant-based proteins like beans. These can help slow down digestion and stabilize blood sugar levels, and they are affordable, accessible, have a long shelf life and can be used in a variety of culturally based foods.

We asked a registered dietitian who is also a certified diabetes care and education specialist (CDCES) for her recommendations for all-star sources of

plant-based proteins. Who knows, you might already have some of these in your pantry or freezer ready to eat right now.

## Benefits of Plant-Based Protein for Insulin Resistance

When plant-based proteins are incorporated into your eating pattern, they can be powerful in insulin resistance, says [Elizabeth Huggins, RDN, CDCES](#), a registered dietitian at Hilton Head Health. Plant-based proteins contain both protein and fiber and tend to be low in saturated fat.

A diet high in saturated fat may be linked to insulin resistance and chronic inflammation, potentially leading to diabetes. Eating plant-based proteins, however, encourages higher fiber intake, potentially lowering the risk of chronic disease.

Additionally, because fiber is indigestible in the small intestine and arrives in the colon intact, the beneficial bacteria in the colon use the fiber as an energy source to make [short-chain fatty acids](#). These short-chain fatty acids may play a role in improving glucose intolerance and insulin sensitivity.

## The 5 Plant-Based Proteins You Should Be Eating for Insulin Resistance

### 1. Dry Beans

Every cup of dry beans contains 15 grams of protein and 15 grams of fiber. When soaked and cooked, dry beans are a low-glycemic-index food, meaning they don't raise blood sugar quickly. Beans are also good sources of magnesium, a mineral that may play a role in glucose metabolism and improve insulin sensitivity.

Huggins says dry beans are also affordable and easy to prepare for delicious soups, salads and bowls. Not sure how to cook dried beans? Follow our [How to Cook Dried Beans](#) method to make some of our favorites, including [Sweet Potato & Black Bean Chili](#) and [Bean Salad with Lemon-Cumin Dressing](#).

## 2. Lentils

Like dry beans, [lentils](#) are full of protein and fiber, providing 15.5 grams of protein and 13.5 grams of fiber per cup. Research notes that the protein in these mighty and colorful pulses may block digestive enzymes from accessing the starch, lessening the amount of glucose your body can absorb from them.

Our [guide](#) explains how to make perfect lentils every time. Then you can enjoy them in an array of dishes, from [Mixed Greens with Lentils & Sliced Apple](#) to [Braised Lentils & Kale with Fried Eggs](#).

## 3. Split Peas

[Split peas](#) are dried and halved green peas with a shorter cooking time. One cup of cooked split peas contains 16 grams of protein and 16 grams of fiber. Soaked and cooked split peas contain [resistant starch](#), which brings down their glycemic load, lessening their blood sugar impact.

[Split pea soup](#) is a classic comfort food that can be whipped up on the stovetop. Split peas don't only come in the green variety—you can also use the golden-colored ones to make [Trinidadian Dal & Rice](#), [Yellow Split Pea Sambar with Turnip, Eggplant & Okra](#) and [Swedish Yellow Split Pea Soup with Ham](#).

## 4. Chickpeas

Fiber- and protein-packed [chickpeas](#) have 14.5 grams of protein and 12.5 grams of fiber for every cup cooked. While they contain starch, these beige-colored

gems also have a unique chemical makeup that makes their starches harder to digest, slowing down carbohydrate digestion and absorption. The result? Potentially lower rises in blood sugar levels.

Try chickpeas to add color and creaminess to satisfying grain bowls, such as our [Turmeric Rice Bowl with Garam Masala Root Vegetables](#) and soups like our [Butternut Squash Soup with Avocado & Chickpeas](#). If you have an air-fryer, pop these ball-shaped beans into the appliance to make [Air-Fryer Crispy Chickpeas](#) or grab a baking sheet and make these [Cinnamon-Sugar Roasted Chickpeas](#) in your oven.

## 5. Edamame

[Edamame](#) has 18 grams of protein and 8 grams of fiber per cup. Soy products such as edamame may positively impact blood sugar regulation, influencing insulin signaling and improving glucose uptake, metabolism and insulin sensitivity.

Conveniently sold as a frozen item in grocery stores, you can cook these shelled baby soybeans as a filling ingredient in our [Herbed Corn & Edamame Succotash](#) and [Egyptian Edamame Stew](#). As a complete protein, edamame lends itself well to one-dish meals like [Slow-Cooker Edamame-Rice Bowl with Cherries & Pecans](#) and [Crispy Rice Salad with Cucumber & Edamame](#).

## The Bottom Line

Regularly incorporating plant-based proteins into your diet may improve glycemic control, blunt blood sugar levels and decrease insulin resistance. Dry beans, lentils, split peas, chickpeas and edamame are five excellent plant-based protein sources that may help combat insulin resistance because of their rich protein and fiber content.

# 10 Superfoods You Don't Need That Much & 10 Worth The Hype

## 1. Kale

©Photo by Brian McGowan on UnsplashDon't get us wrong—kale is undoubtedly one of the healthiest foods on the market. It's packed with vitamins and potassium, comes with all kinds of fiber, and is known to aid digestion. However, kale is often touted as the champion of leafy greens while other (sometimes healthier) options are ignored. Don't rely on kale for all your health needs; spinach and broccoli are just as good, if not better, in some areas.

## 2. Dark Chocolate

Over the years, dark chocolate's flavonols have been credited with heart health, better skin, and a lower risk of high blood pressure. It's also loaded with antioxidants and ultimately makes a healthy treat, however, people heard, "Chocolate is good for you!" and ran with it. Dark chocolate shouldn't be consumed every day and isn't a cure-all for heart trouble or poor memory.

## 3. Goji Berries

Berries are indeed good for you, but the trick is nailing down which ones are actually beneficial. While goji berries do pack a healthy punch, their benefits are often outweighed by the high calorie count and potential to disrupt certain medications, particularly blood thinners or meds for diabetes.

## 4. Agave Syrup

In a mad dash to find healthy natural sweeteners, consumers were misdirected to equally unhealthy choices. Agave syrup is one of those culprits. Its glucose is on the lower side, but its fructose is far higher than other sweeteners, leaving you vulnerable to weight gain or health concerns.

## 5. Coconut Water

Coconut water is packed with electrolytes, so plenty of gym-goers turn to it for replenishment. However, it also has a decent amount of sugar and despite the benefits isn't for everyone. Anyone with high amounts of potassium should keep well away, or those who don't need any added sodium to their diet.

## **6. Chia Seeds**

Like anything in life, chia seeds are best enjoyed in moderation rather than used as a go-to cure. Chia seeds come with great benefits like omega-3 fatty acids and cholesterol-reducing properties, but they can also cause weight gain or digestion issues on account of their high fiber.

## **7. Acai Berries**

Not only are acai berries pricier than your average berry, but their antioxidants are often praised as offering more than they really do. Sure, they help lower blood sugar and can assist with reduced inflammation, but they don't really do more for you than the everyday berry like blueberries or strawberries.

## **8. Chili Peppers**

At first glance, chili peppers seem like a godsend for spicy food lovers—they're rich in vitamin C, can reduce inflammation, and have been tied to longer life expectancy. On the flip side, hot peppers are prime causes for diarrhea, digestive problems, and stomach pain. You can score these health benefits from other foods that are far gentler.

## **9. Coconut Oil**

Coconut oil was all the craze for a while; people used it for their hair, in their food, and swore by the health benefits. While it may help with liver function and keep you fuller longer, coconut oil also has a ton of saturated fat, which doesn't help your overall health. At the end of the day, it isn't better than olive oil when cooking.

## **10. Green Tea**



Green tea is perfectly safe for most people in moderation, but you'll want to mind how much you consume. Given that there's caffeine, excessive consumption leaves you susceptible to common side effects like insomnia, headaches, or even dizziness. Not all hope is lost with "superfoods." Plenty are well worth the hype and should be incorporated into your diet more often!

## **11. Leafy Greens**

Remember how we said kale is part of leafy greens, not the only leafy green? That's because spinach, chard, and collard greens have just as many benefits. Spinach, for example, is loaded with more vitamins and calcium than kale while chard has more iron. The healthiest diets include leafy greens as a whole!

## **12. Sweet Potatoes**

Those sweet potato fries may be more expensive, but this veggie is worth tossing into your diet more often thanks to its fiber and vitamins—specifically vitamin A, which keeps your eyes healthy. They're a low-calorie option that also help with digestion and support immune health.

## **13. Berries**

If you're looking for common berries rich with antioxidants, fiber, and vitamins then you needn't go further than strawberries, raspberries, and blackberries. Much like goji or acai berries, these guys have all the good stuff you know and love, but won't cost an arm and a leg to get. They're also have way fewer calories.

## **14. Eggs**

Eggs are pretty high in cholesterol, so it's always worth checking with your doctor about how many you can safely eat. That said, studies suggest they're generally one of the healthiest foods due to their nutrients, vitamins, and protein. They're also great for all age groups, making them one of the versatile foods, too.

## **15. Ginger**

Is there anything we don't expect ginger to cure? It's hard not to love it considering ginger soothes upset stomachs, helps our immune systems, and comes packed with vitamins and antioxidants. The only thing you'll want to pay attention to is dosage—too much of it can cause the opposite effect, leading to heartburn or stomach upset.

## **16. Salmon**

The hype around salmon is true! It's rich in omega-3 fatty acids, can reduce inflammation, comes with all kinds of vitamins, and supports heart health. It's also fairly versatile, easily seared or baked alongside other healthy veggies for an ultimate protein-rich dinner.

## **17. Turmeric**

Turmeric does all kinds of work to keep you healthy; it helps proper digestion, supports joint health, and has plenty of anti-inflammatory properties. It's also been used as an aid for symptoms of depression, arthritis, and allergies.

## **18. Avocado**

Avocado this, avocado that—it seems like you can't get away from the recommendation, but there's good reason! Well, there are several reasons because avocados are loaded with healthy fats and nutrients, they help weight management, and are easily included in a variety of meals.

## **19. Legumes**

Legumes include several foods like chickpeas, lentils, and beans, all of which make terrific additions to your diet. You may have already heard that they're packed with protein, but legumes also have all sorts of vitamins, iron, and fiber. They're also low in fat and don't come with any saturated fats.

## **20. Onions**

Onions are pretty polarizing, but if you're willing to peel the layers you'll discover just how beneficial they are to your health. They lower your risk of some cancers, come with antioxidants, and are also a good source of vitamin

C. They might not be best for breath, but their health benefits outweigh the need for a toothbrush.

## **5 Reasons Why You Should Eat an Avocado per Day**

Health and nutrition experts now refer to avocado as a superfood, and this is for a reason. Originally from Central America, the creamy and smooth fruit is full of fiber, protein, and essential vitamins, which play a critical role in your overall health.

Previously, there were misconceptions about avocados being high in cholesterol due to their fat content. However, avocados contain healthy unsaturated fats that can lower bad cholesterol levels.

If you're still curious about the benefits of avocados, here are five more reasons to eat an avocado daily.

### **Avocados Can Help You Maintain a Healthy Weight**

Avocados have healthy fats, vitamins, minerals, and fiber, promoting satiation and keeping you full. That translates to less snacking on non-nutritious foods or overeating. Over time, that leads to weight loss as you have a more mindful and balanced approach to eating. Furthermore, the high fiber content in avocados has been linked to lower BMI and body weight.

### **Avocados May Reduce Heart Disease Risk Factors**

Avocados are a superfood, rich in magnesium, fiber, potassium, antioxidants, and essential fatty acids that help protect your heart.

The Journal of the American Heart Association conducted a study in 2022 and found that people who had two servings of avocado each week had a 21% lower risk of a heart attack and a 16% lower risk of heart disease. Avocado

consumption is also associated with lower blood pressure, a significant risk factor for heart disease.

## **Avocados Are Great for Your Eye and Brain Function**

Avocados are a rich source of carotenes, including zeaxanthin and lutein. They also have protective Vitamin E that can help keep your eyes healthy. Lutein, a phytochemical in avocado, plays a role in brain function. Research on older adults discovered that eating an avocado a day improved brain performance, and they could perform better on memory results. Interestingly, most people who took a lutein supplement didn't experience the same results. The high folate content in avocados has been shown to lead to the production of chemicals that regulate your appetite, mood, and sleep.



## **Avocados Are Full of Anti-inflammatory and Antioxidant Compounds**

Avocados are full of carotenoids and contain the antioxidant vitamins E, C, and A. These antioxidants slow down the aging process and can help prevent diseases like cancer. The fruit also contains omega-3 fatty acids that lubricate joints and aid in treating osteoarthritis.

Avocadoes have unique fats like beta-sitosterol, phytosterol, and stigmasterol that keep inflammation under control.

## **Avocadoes Are Versatile**

Avocadoes are not only delicious but also versatile. You can incorporate them into your breakfast by pairing them with toast and fresh vegetables or toss frozen pieces into your morning smoothie for healthy fats. You can replace your salad dressing with avocado at lunchtime and add vegetables, nuts, and protein. Alternatively, combining onions, lime, cilantro, and avocado makes a classic guacamole for tacos.

You can add avocado to your salad bowl during dinner, top your soups with sliced avocado, or make a delicious dairy-free avocado chocolate mousse.

Avocadoes are delicious and have plenty of health benefits. Avocados are a daily must-have for fetal development, weight management, insulin sensitivity, heart health, and skincare. Its versatility also allows you to experiment with different recipes, which makes avocados a superfood.

# VEGAN PROTEIN

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8 Ways to Add a Meaty Taste to Plant-Based Dishes© kool99/Getty Images

If you browse through the *Taste of Home* archives, you'll find that [I've written a lot of articles about meat](#). I share tips for cooking [the perfect burger](#), breaking down chicken and a *ton* of advice about working with steak. I love meat because of its rich, savory flavor, but I've found myself eating less and less of it over the years.

Because sustainable, pasture-raised or grass-fed meat is more expensive than conventional options, I started making vegetables a larger component on the plate. Then, I began cooking meals with (gasp!) no meat at all.

What did I find? [Plant-based meals](#) are incredibly satisfying, especially if you focus on building meaty flavors into each dish. That's where [umami](#) comes in. Umami is one of the five tastes (along with salty, sour, bitter and sweet), and it's most concisely summed up as savory flavor. It's what makes a grill-marked steak, a rich tomato sauce or a Parmesan cheese-topped portobello mushroom taste extra yummy.

Umami is found in meat, but knowing how to create umami flavor with veggie-friendly ingredients will make it easier to build meaty flavor into plant-based meals. Vegan umami is possible!

## How to Create Umami Flavor

Coaxing maximum flavor out of plant-based ingredients is all about building layers of flavors. Start with beans, vegetables like tomatoes, mushrooms, peas or corn, or soy-based ingredients like tofu or [tempeh](#). Then, add one or more of the following ingredients as you cook.

The ingredients will all work together to create a complexity that takes your dish from fine to fantastic without a ton of extra effort.

## Premade Spice Blends

Since creating plant-based umami is all about layering several umami-rich ingredients into a dish, using spice blends is a great way to get started.

Mushroom-based blends like this [Porcini Mushroom Powder](#)

If mushrooms aren't your thing, look to blends that contain black garlic, an aged garlic that's simultaneously sweet and earthy. Alternatively, smoky ingredients—like smoked salt, chipotle powder, smoked paprika or ground cumin—are good options, too. Their rich flavor and smoky aroma go a long way to transform a simple meal.

## MSG

MSG is a bit of a taboo ingredient. For years, many [people feared MSG sensitivity](#), worrying it might cause everything from itching to headaches and other symptoms. So why would we suggest using it to create umami flavor? Because it's incredible at making anything umami taste *more umami*.

Short for monosodium glutamate, MSG is an FDA-approved food additive that's derived from glutamic acid (one of the essential amino acids found in complete proteins). It enhances meaty flavors, making [plant-based ingredients](#) like tomatoes, mushrooms and soy taste more savory. You'll only need a small amount (about 1/8 teaspoon) if using it as a finishing seasoning, or you can add as much as 1/2 teaspoon to sauces or soups while they simmer to amp up the flavors.

## Liquid Smoke

Before we get started, we must caution you: It is *really* easy to overdo it with liquid smoke, so be sure you know [how to use liquid smoke](#) without going overboard. In small quantities, liquid smoke makes anything taste like it came straight off the charcoal grill. (Wondering [what is liquid smoke](#)? We've got you covered.) In larger quantities, though, it creates extremely bitter flavors and carries an unpleasant aftertaste. We like adding it to marinades for roasted or [grilled vegetables](#) or adding a little bit to homemade sauces. About a teaspoon per cup of sauce should do the trick nicely. Get started with these [liquid smoke recipes](#).

## Nutritional Yeast

[Nutritional yeast](#) is grown specifically to be used as a food product. These yellow flakes are naturally high in glutamic acid, and they work well as both a finishing and cooking ingredient. Add nutritional yeast to hot soups, puree it into [cashew](#) creams or mix it with grains, and the nutty flavor will melt in and permeate every bite. Alternatively, a finishing sprinkle adds a Parmesan cheese-like finish to popcorn, toast or roasted vegetables.

## Black Vinegar

Black vinegar is made from fermented rice, wheat, barley and sorghum. It has a distinctly sweet-tart flavor that doesn't taste great on its own—but combine it with other umami-rich ingredients and it boosts the richness of the entire dish.

If you don't have black vinegar in the pantry, balsamic vinegar will work in a pinch. It's sweeter and less funky than black vinegar, but it still works to pull together the other flavors.

## Miso Paste

This fermented soybean paste is perfect when you want to add vegan umami flavor while also increasing the body of a saucy dish. There are several [different kinds of miso paste](#), and each adds a unique flavor to your cooking. We love using miso as a finishing ingredient in soups or sauces, swirling a tablespoon into the sauce until it's well combined. It can also be used to glaze vegetables, make a stellar [salad dressing](#) or as a [substitute for butter](#) in carbonara pasta.

Keep in mind that miso paste is pretty salty, so you'll want to reduce the amount of salt in the dish when using it.

## Seaweed

The most effective way to create an umami-rich vegetable broth is to add kombu to the mix. This seaweed is an edible kelp that's used to make dashi, the broth used in [miso soup](#). Combining kombu and mushrooms creates a liquid that's almost as rich as meat-based broths.

Roasted seaweed snacks are another great way to add extra flavor to veggie dishes. Look for sheets roasted with olive oil or sesame oil and sprinkled with a little finishing salt. Add them as a garnish to rice and pasta bowls for a salty, savory finish.

## Tamari or Soy Sauce

When in doubt, a splash of soy sauce, gluten-free tamari or vegan Worcestershire sauce usually does the trick. These ingredients are umami bombs, full of salty and savory flavors that can really elevate the other layers you've created. Most Worcestershire contains anchovies, so seek out a vegan Worcestershire (like [Annie's Naturals](#)) if you're concerned.

## Tips for Adding Meaty Texture

In addition to using umami-rich ingredients, you'll want to consider the texture of your dish. The right ingredients will help enhance the vegan umami flavor.

- Tempeh, [seitan](#) or pressed extra-firm tofu work well as substitutes for steak, pork, chicken or fish. You can also look to vegetables that can be cut into "steak" shapes, like cauliflower, sweet potatoes, zucchini, winter squash or beets.
- Mushrooms have a naturally meaty texture, so they're excellent options as the star of vegetarian dishes. Try using whole portobello mushroom caps to create plant-based burgers, or sautee the strips for a vegetarian-friendly Philly cheesesteak. Smaller mushrooms are ideal for skewers, rice, pasta or stir-fry dishes.
- Beans are incredible, no matter how you cook them. They'll add a dense, chewy texture to soups and stews, and they can be combined with oats to create [vegetarian burgers](#).
- Quinoa has a delightfully nutty texture, and it tastes almost exactly like ground beef when mixed with cooked lentils. Try adding the combination to a taco salad,



- For a dish that requires shredded meat texture (like tacos or sandwiches), look to [jackfruit](#). This mild-flavored fruit usually comes prepared in a can or pouch, and all you'll need to do is toss it with your sauce.

# Our Test Kitchen Found the Best Plant-Based Burger Brands

By [Lisa Kaminski](#)

[Taste of Home's Editorial Process](#)

Updated Apr. 21, 2023

Fire up the grill and grab the best plant-based burger brands as chosen by our Test Kitchen. Our pros tested nine patties to find the ones that really satisfy.



TASTE OF

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Many of us are looking for ways to trim meat from our diet. For many dishes, it's simple: trying [eggplant Parmesan](#) instead of its chicken-based cousin, topping our [pizza with heaps of veggies](#) or making [hearty bean-filled chili](#). Things get a bit trickier when it comes to classics like a juicy flame-grilled burger. Finding the right substitute for a classic beef burger is challenging. Which plant-based burger really satisfies?

We know you don't want to spend every burger night sampling veggie-based options. That's why our Test Kitchen snagged every plant-based burger they could find and hosted the biggest veggie-friendly barbecue.

Psst! Learn [how to create umami flavor](#) in plant-based foods.

## What We Looked for in a Great Plant-Based Burger

In this search for the best plant-based burger, our Test Kitchen kept a bunch of criteria in mind. They wanted a veggie burger that was delicious, satisfying and perfect for the grill. These are what our pros judged on:

- **Flavor:** How did the burger taste? Is it similar to a beef patty? If not, what other flavors are prominent? Is it enjoyable? Filling?
- **Texture:** Was the texture pleasant? Meat-like?
- **Appearance:** Does the patty look like beef? Did it grill nicely? Does it look like something you want to pile high with toppings and dive into?

## Our Test Kitchen Preferred Plant-Based Burger Brands





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After testing nine brands, our Test Kitchen found a few winners deserving of a place on the [grill](#) (or [griddle](#)). We think you'll flip for them, too.

## Best Veggie Burger for Meat Lovers:



## Impossible Burger

If you're a beef burger fan that's looking to make a healthier switch to meatless burgers (at least some of the time), you'll want to pick up [Impossible Burger](#).

These much-hyped burgers were one of our Test Kitchen's favorites because Impossible really replicated the experience of a beef burger with soy and other veggie ingredients. This burger looks like a real burger, sears up like a real burger, has the texture of a real burger and tastes a lot like...yep, a real burger. This patty had even our most serious burger fans willing to reach in for seconds.

Snag these for your next barbecue, pile high with toppings and no one will ask, "Where's the beef?"

## Most Filling Meat-Free Burger: Sweet Earth Awesome Burger



TASTE OF HOME

Get your fill with the [Sweet Earth Awesome Burger](#). These patties are made of pea protein and pack a whopping 25 grams of protein per serving—that's comparable to a traditional beef burger.

But these burgers are good for more than a protein fix. The texture of the Sweet Earth Awesome burger was so similar to beef that it had a

few Test Kitchen staffers double-checking. The nice sear, along with the thickness and flavor, made for a satisfying combo—plus a pleasant departure from a lot of the soy-based options that dominate the meatless burger market.

## **Best Grill Flavor (Without the Grill): Boca All American Veggie Burgers**



TASTE OF HOME

When it comes to veggie burgers, everyone recognizes Boca. It's the original! And [Boca All American Veggie Burgers](#) remain a great option for vegetarians looking for flame-grilled flavor.

Boca's classic veggie burger has a touch of built-in barbecue flavor thanks to [liquid smoke](#). This is great if you're craving a burger but don't have time to fire up the grill. These patties browned up nicely and had a great [umami](#) flavor—not necessarily meaty but savory, the way mushrooms can be. Topped with a slice of cheese and some fried onions, these burgers are a great option for veggie-lovers looking for a quick barbecue fix.

**TEST KITCHEN APPROVED**

# Hearty Vegetarian Chili

**PREP TIME**20 min

**COOK TIME**10 min

**YIELD**9 servings (2-1/4 quarts)

## Ingredients

- 1-3/4 cups chopped baby portobello mushrooms
- 1 medium onion, finely chopped
- 1/2 cup chopped sun-dried tomatoes (not packed in oil)
- 2 tablespoons olive oil
- 2 garlic cloves, minced
- 1 package (12 ounces) frozen vegetarian meat crumbles
- 2 cans (16 ounces each) chili beans, undrained
- 2 cans (14-1/2 ounces each) no-salt-added diced tomatoes
- 1/2 cup water
- 1/2 cup vegetable broth
- 4-1/2 teaspoons chili powder
- 2 teaspoons brown sugar
- 1/2 teaspoon celery salt
- 1/2 teaspoon ground cumin
- 1 medium ripe avocado, peeled and finely chopped
- Reduced-fat sour cream, optional

## • Nutrition Facts

- 1 cup: 238 calories, 8g fat (1g saturated fat), 0 cholesterol, 611mg sodium, 34g carbohydrate (9g sugars, 12g fiber), 14g protein. **Diabetic**  
**Exchanges:** 2 vegetable, 2 lean meat, 1-1/2 starch, 1 fat.





Harvard nutritionist says these are the 4 best changes you can make to your diet for a healthy brain© Provided by CNBC

The decades-old saying "you are what you eat" has grown increasingly true as we learn just how important our diets are for [immunity](#), [longevity](#) and even mental health.

"Many people don't realize that there's a way in which the food we eat impacts our mental wellbeing," according to [Dr. Uma Naidoo](#), a Harvard-trained nutritional psychiatrist and author of "[Calm Your Mind with Food](#)."

"The food we eat, as it gets digested, interacts with the trillions of microbes in the gut microbiome, and gets broken down into different substances, which then subsequently over time impact our mental wellbeing. Some of the foods that are less healthy, if we're eating them, set the gut up for inflammation."

**[DON'T MISS: 4 simple ways to eat for longevity in the new year, according to a Harvard nutrition expert](#)**

Inflammation in the gut can lead to several adverse mental health symptoms, Naidoo says, including anxiety.

"By tweaking your diet back to a healthier norm, you can actually help to relieve some of these symptoms," she notes.

Here are four simple changes you can make to your diet for better brain health.

## **The 4 best changes you can make to your diet for a healthy brain**

### 1. Increase the fiber you eat

"An easy first step is to increase the fiber in your diet," Naidoo says.

"An increased intake of total dietary fiber" was associated with a lower chance of developing depression, according to a [study](#) published in "Complementary Therapies in Medicine" in 2021.

The best way to get fiber in your diet is to obtain it from plant-based foods, Naidoo says.

These are a few great food sources that are high in fiber:

- Colorful vegetables **like leafy greens**
- Beans and other legumes
- Flax seeds
- Healthy whole grains

### 2. Get more polyphenols

Naidoo refers to this method as getting a "kaleidoscope of color" in your diet by [eating colorful foods](#) that are high in polyphenols. Different plants and

vegetables of different colors "represent a level of biodiversity needed by the gut microbes," she says.

Aim to eat more [foods rich in polyphenols](#) like:

- Carrots
- Blueberries
- Strawberries
- Nuts, especially hazelnuts and pecans
- Black olives

"All of these are hugely important, because they have anti-inflammatory, antioxidant properties [and] fiber, plus multiple micronutrients that our bodies need," Naidoo says.

### 3. Eat foods rich in probiotics

A healthy gut is great for our brains, and our guts love [probiotics](#). And you can get more of the healthy bacteria from fermented foods.

"A [study](#) published in 'Cell,' a very highly reputable journal, done by a research group at Stanford University a couple of years back, showed that adding fermented foods to your diet lowers inflammation," Naidoo says.

Naidoo recommends finding a fermented food that appeals to you, whether it be kefir, kimchi, yogurt or kombucha.

### 4. Use more herbs and spices

One of the simplest ways to improve your gut health, which can also promote healthy brain health, is by adding more spices and herbs to your diet, Naidoo says. It's "something people often overlook," she adds.



"Spices and different types of fresh herbs are [rich in plant polyphenols](#), high in antioxidants and anti-inflammatory properties," Naidoo says.

You can spice up your meals with:

- Turmeric and a pinch of black pepper
- Capsaicin from chili peppers
- Mint
- Oregano
- Parsley
- Thyme
- Ginger
- Garlic

"They flavor up your food [and] they add depth, whether you make a soup or roast vegetables or a piece of salmon," Naidoo says, but they're also "a powerful part of our kitchen that we can lean into."



Getty Images/LeoPatrizi© Provided by The Weather Channel

- **A new study has found that plant-based diets are linked with better health.**
- **People eating vegetarian and vegan diets had a lower risk for heart disease and cancer.**
- **They were also less likely to die from cardiovascular disease.**
- **Plant-based diets are low in cholesterol and saturated fat, but high in nutrients.**
- **A flexitarian diet composed of whole foods may be the best plant-based diet.**

A new scientific literature review has found that vegetarian and vegan diets help improve cardiometabolic risk factors, such as elevated lipids, blood sugar, body weight, BMI, and inflammation.

The individuals studied also had a lower risk of ischemic heart disease and gastrointestinal and prostate cancers.

The authors of the [study](#), which was published on May 15, 2024, in the journal *PLOS ONE*, further stated that people who ate vegetarian diets were at reduced risk for dying from cardiovascular disease.

They did note, however, that pregnant people eating vegetarian diets did not appear to have any difference in their risk of developing gestational diabetes and high blood pressure.

## Over 20 years of research highlight the health benefits of plant-based diets

The authors wrote that prior studies have shown that diets low in plant foods and high in meat, refined grains, sugar, and salt are associated with a greater risk of death.

They said this suggests that eating a more plant-based diet should have the opposite effect, reducing the risk of cardiovascular disease and cancer.

To see whether this assumption held up, the researchers examined 48 papers published over a 23-year span.

They selected papers that dealt with plant-based diets and their effects on cardiovascular health and cancer risk.

They used an [umbrella review approach](#), taking data from all the studies and analyzing it.

This method is unique in that it only uses the highest-level evidence, which is other systematic reviews and meta-analyses.

When they analyzed the two decades of compiled data, they found that the association between vegetarian and vegan diets and reduced cardiometabolic risk factors was quite strong.

The research team conceded, however, that the study had some limitations, such as variations in the exact diet followed, patient demographics, and study length.

## Why plant-based diets help reduce health risks

[Dr. Libbat Shaham](#), a board certified family physician with Medical Offices of Manhattan and contributor to LabFinder.com, who was not involved in the study, commented on the study, explaining that the observed improvements in health may come down to what plant-based diets don't contain: cholesterol and high levels of saturated fat.

"Cholesterol and saturated fat over time are what lead to damage to, and obstruction in, blood vessels — the cause of heart attacks and strokes," she explained.

Shaham went on to say that saturated fat is mostly found in animal foods and is solid at room temperature.

"Cholesterol is made in the liver," she added. "Plants don't have livers. Animals do."

[Dr. Sarah Bonza](#), a board certified physician specializing in family medicine and lifestyle medicine, who was not involved in the study, added that plant-based diets also may help reduce the risk of chronic diseases because of what they do contain, which are vitamins, antioxidants, and fiber.

"Fruits, vegetables, whole grain, legumes, nuts, and seeds ... all contain vitamins, minerals, and [phytonutrients](#) that benefit people's health," she said. "With these meal plans, one may expect fewer inflammations and improved heart and immune health."

Bonza additionally pointed out that the fiber in plant foods helps speed up the [digestion](#) process and keeps the gut microbiome healthy.

## What's the best plant-based diet?

While the study looked at vegetarian and vegan diets, [Faith Krisht](#), a Registered Dietitian Nutritionist who was not involved in the study, advises that the best way to eat plant-based is to follow a flexitarian diet.

"Research [shows](#) that vegan and vegetarian diets are often deficient in [essential fatty acids](#) such as EPA and DHA, Vitamin B12, Vitamin D, and [iodine](#)," she said. "These are all important nutrients for human health."

A flexitarian diet — which focuses on eating mainly plant-based proteins while occasionally adding animal-based proteins — helps ensure that you are getting all the vital nutrients that you need.

Krisht also recommends eating a diet that is high in whole foods rather than one that is high in refined and ultra-processed foods.

"This means a diet that is rich in whole grains, beans, lentils, vegetables, fruit, seeds, nuts, minimally processed animal proteins," she said.

According to Krisht, this ensures that you get plenty of healthy fiber and antioxidants while also avoiding [added sugars](#), which can increase your risk of chronic disease.

## How to incorporate more plant-based foods into your diet

Krisht said a simple way to add more plant-based foods to your diet is to incorporate them into meals you already enjoy.

“Add [black beans](#) to your taco meat or in a quesadilla, add chickpeas to your curry, throw some [edamame](#) into your stir-fry, add pumpkin seeds to your morning [oatmeal](#),” she suggested. You can start small and work your way up to more.

Krisht said that one thing she likes to do is keep a variety of seeds on hand, such as sesame, sunflower, chia, flax, hemp, and pumpkin.

These can easily be added to yogurt, smoothies, oatmeal, salads, baked goods, and even regular meals.

“You can also try adding various whole grains to your white rice such as farro, quinoa, or wild rice,” she said.

## Takeaway

Over 20 years of studies have found that plant-based diets can improve cardiometabolic health and help prevent cancer.

Experts say this is because plant foods are low in cholesterol and [saturated fats](#) while being high in other desirable nutrients like vitamins, antioxidants, and fiber.

The best plant-based diet may be one that is well-rounded in nutrients due to occasional meat intake. It should also be filled with whole foods.

To start eating more plant-based foods, start slowly and try incorporating them into your current diet.

Whether it started as an accident tracing back to around 1000 BCE or as a means to preserve the milk extracted from newly domesticated animals (via Encyclopedia Britannica), cheese has become a beloved dietary staple for people around the globe for millennia. Through a complex fermentation process involving bacteria, rennet, and salt, milk can transform into countless variations, which are so popular that the [American Cheese Society \(ACS\)](#) even holds numerous yearly programs and competitions to celebrate it, boasting numerous diverse categories that classify cheeses according to milk type, chemical composition, aging characteristics, sensory properties, specific cheese styles, and varieties, to mention a few.

Nevertheless, while cheese's place in human history can't be denied, its healthfulness is often challenged. On the one hand, cheese is rich in nutrients like calcium and protein while also packing a range of vitamins and health-promoting compounds, such as conjugated linoleic acid (CLA), an omega-6 fatty acid that may support heart health (per [Healthline](#)). In addition, some types of cheese, especially those that are aged and unpasteurized, can also offer probiotics, promoting a healthy gut microbiome (via [Harvard Health Publishing](#)). On the other hand, cheese can also have a high saturated fat and sodium content, depending on the variety. Ultimately, many varieties boast surprising advantages, making them a nutritious option when included mindfully in the diet. Keep reading to discover which cheeses should make it past your shopping cart and into your table on your next cheese run.

Read more: [Healthy Snacks That Can Help You Lose Weight](#)



# Feta Cheese



Feta cheese on wooden cutting board© Westend61/Getty Images

Few foods scream "Greece" more than feta cheese, seeing that, according to a [study](#) published in *Foods*, this Greek staple is the most consumed cheese in the country. In fact, cheese is a protected designation of origin (PDO) food, meaning that it must be produced in specific areas within the country to earn the name. The flavorful cheese is traditionally made from sheep's milk or a combination of sheep and up to 30% goat's milk. Its production involves curdling the milk with lactic acid and rennet, draining the whey, and cutting the curd, after which the curds are salted and stored in a brine solution. This process gives feta its crumbly texture and distinctively tangy, salty flavor (via [Healthline](#)).

Regarding feta's health benefits, the cheese is known for boasting a lower fat content compared to some aged cheeses, most of which are comprised of CLA, which may help reduce your risk of obesity and diabetes while providing additional [cancer-fighting properties](#). Moreover, its nutritional profile, namely its calcium, protein, phosphorus, and probiotic content, may benefit your bone and gut health. Despite its benefits, feta has some potential downsides, notably its high sodium content due to the brining process. In fact, the study found that this cheese might be responsible for the elevated salt intake among Greeks, which surpasses the World Health Organization's (WHO) recommended limit of five grams per day. Still, feta cheese is a highly versatile food that can be used for

dishes ranging from salads and sandwiches to entrées and desserts thanks to its bold flavor, which pairs nicely with fresh and hearty ingredients.

## Ricotta Cheese



Ricotta cheese in ceramic bowl© Burcu Atalay Tankut/Getty Images

Soft and creamy, [ricotta](#) is coveted for its fluffy yet spreadable texture and mildly sweet flavor, a combination of organoleptic characteristics that turn the cheese into the ideal ingredient for both savory and sweet dishes, such as dips, lasagna, stuffed pasta, cheesecake, and pastries (via [Cheese.com](#)). While ricotta is widely recognized as a type of cheese, the site explains that, technically, it isn't. In fact, it is made from the leftover whey from other cheeses, typically from cow, sheep, buffalo, or goat's milk. Its production involves recooking the whey and straining it through a cheesecloth to gather the newly formed and smaller, softer curds (via [Encyclopedia Britannica](#)). The process's recooking part leads to the cheese's name, seeing that ricotta is the Italian word for recooked.

Nutritionally speaking, ricotta is a rich source of protein and calcium, with half a cup providing a whopping 10 grams of the macronutrient and over 20% of the mineral's daily value (DV), per the [USDA Food Data Central](#). Additionally, the Encyclopedia Britannica explains that this cheese has another nutritional advantage over other spreadable cheeses, like cream cheese or mascarpone, by providing a significantly lower fat content. On that note, a [review](#) published in The Journal of Dairy Science shares that ricotta cheese delivers monounsaturated

and polyunsaturated fatty acids, the healthy kind that helps with heart health. However, keep in mind that since ricotta cheese is made from leftover whey, which consists of lactose and water, it may be an unsuitable choice for people with lactose intolerance.

## Cottage Cheese



Cottage cheese in wooden bowl© Pixel-Shot/Shutterstock

Favored among health enthusiasts and popular for its versatility in the kitchen, [cottage cheese](#) is a fresh cheese made from cow's milk. This cheese is characterized by its soft yet lumpy texture, courtesy of its distinctive curds, and you may easily find it in different fat content levels, ranging from full-fat to low-fat and fat-free versions. Among its many health-promoting attributes, cottage cheese is especially popular for its high protein yet low-calorie content. For example, a one-cup serving of low-fat cottage cheese boasts 24 grams of protein while only providing 180 calories (via the [USDA Food Data Central](#)), and did we mention the same serving has a mere five grams of fat? No wonder both athletes and dietitians swear by this cheese.

Due to its nutritional profile, cottage cheese is often the go-to choice in weight loss diets, especially the low-fat varieties, seeing that its high protein content helps prolong feelings of fullness, which helps keep your appetite in check (per the [Cleveland Clinic](#)). In addition, the site explains that its protein content also comes in handy when trying to pack some muscle, mainly due to the effects of

casein on muscle synthesis and recovery. Plus, like most other cheeses, it also boosts your bone health. On the downside, cottage cheese might not be well tolerated by people with lactose intolerance, who might experience bloating and abdominal pain due to its high lactose content (per Healthline). If you're thinking about adding cottage cheese to your diet, try it on its own over toast or crackers, mixed with fruits, or added to savory dishes like salads and scrambled eggs.

## Mozzarella Cheese



Sliced fresh mozzarella cheese© Dimitrie Ragar / 500px/Getty Images

Commonly known for its distinct round or sphere-like shape and mild flavor, mozzarella cheese is an Italian fresh cheese originally made from buffalo's milk. However, cow's milk varieties are also available in the market. What probably distinguishes this cheese from other types of fresh cheeses is its processing method. After curdling the milk, cheesemakers perform a technique called pasta filata (which roughly translates to stretched curd) in which they mix the curd with hot whey and then stretch it and knead it until it becomes soft and elastic (per [Cheese Origin](#)). This ensures the cheese gets its uniquely soft and springy texture and rounded shape.

Regarding its nutritional properties and health benefits, mozzarella cheese is a good source of vitamin B12, with a single ounce of cheese providing 30% of the nutrient's DV (via the [USDA Food Data Central](#)). Vitamin B12 is essential for DNA and red blood cell formation, as well as for keeping a healthy nervous system.



Since the vitamin is naturally available only through animal-based foods, mozzarella cheese is an especially important food item for those [following vegetarian diets](#). Culinarily speaking, mozzarella cheese is deeply engrained in Italian cuisine, as its melting capacity has made it an indispensable ingredient for pizzas, lasagnas, and baked pasta dishes. Yet, you may also find it in cold dishes like salads and paninis, namely the famous Caprese salad.

## Cheddar Cheese



Shredded cheddar cheese in a bowl© Bhofack2/Getty Images

Sharp in flavor and bold in color, cheddar is an English gift to the world of cheese. The cheese is produced with cow's milk, and it follows a unique processing method called "cheddaring," which involves having the firm curd cut, stacked, and pressed to remove moisture. Then, the cheese is left to age anywhere from three months to two years, granting it its bold flavor, which heightens with age. While many associate cheddar cheese with not-so-healthy dishes like nachos, it may surprise you that its nutritional profile might grant it cholesterol-lowering properties, namely due to its protein and calcium composition (per [WebMD](#)).

Moreover, according to a [study](#) published in The Journal of Dairy Science, cheddar cheese might be a good source of beta-carotene, the pigment responsible for the cheese's color, which also has antioxidant and anti-inflammatory properties (via the [Cleveland Clinic](#)). Plus, cheddar cheese provides

significant amounts of CLA, ranging from 0.15 to 0.44 grams per 100 grams of cheese, depending on the feeding system used to feed the cows. For reference, CLA has a recommended daily intake of between 0.8 and 3.2 grams. Whether you prefer it shredded, cubed, sliced, melted, or in a solid block, you could say that cheddar's versatility in the kitchen is unmatched. From mac and cheese to charcuterie boards, grilled cheese sandwiches, and casseroles, its bold flavor will surely be the star of your meal.

## Goat Cheese



Slices of goat cheese with thyme© Ramses02/Getty Images

[Goat cheese](#), or chevre, is a healthy and typically creamy and spreadable cheese. Yet, it can be turned into a firm and crumbly one when aged. Either way, goat cheese is perfect for those who have trouble tolerating cheeses made from cow's milk, seeing that it has a naturally lower lactose and casein concentration, meaning that people with lactose or casein intolerance won't struggle as much to digest it (via [Healthline](#)). In addition, the site explains that goat cheese contains medium-chain fatty acids (MCFAs), a healthy type of fat that, according to a [study](#) published in the Journal of Functional Foods, has multiple health-promoting benefits, including aiding weight loss by increasing satiety and energy expenditure, boosting heart health by preventing atherosclerosis, enhancing blood sugar control by improving insulin resistance, counteracting memory impairment in people with Alzheimer's Disease, and even providing anti-cancer properties, as well as anti-convulsant effects for people with epilepsy.



When it comes to cooking with goat cheese, its texture and flavor make it a tasty addition to breakfast dishes like omelets or toast. You can also find it in main courses and side dishes as part of salads, roasted veggies, pizzas, or pasta dishes, and even in desserts paired with fruit and honey. In short, goat cheese's healthfulness and deliciousness can easily become a part of your diet in both gourmet and everyday meals.

## Swiss Cheese



Blocks of Swiss cheese with knife and Swiss flag© barmalini/Shutterstock

Known for its iconic holes, also known as eyes, Swiss cheese is a pale yellow hard cheese made from cow's milk with a sweet but nutty flavor. However, according to [Cheese.com](https://cheese.com), the larger the eyes, the bolder the flavor. The cheese's famous holes are formed during its manufacturing process. Unlike other cheeses, after the milk curds are formed and drained, they're mixed with lactic acid-producing bacteria and left to age and ferment. This fermentation is the part of the process that leads to the formation of the characteristic holes. Nutritionally speaking, Swiss cheese is an excellent source of protein, vitamin B12, and calcium, with a single slice providing 28% and 25% of the DV for the vitamin and mineral, respectively (via the [USDA Food Data Central](https://www.ars.usda.gov/nutrition/)), supporting bone health and DNA metabolism.

Swiss cheese also contains lower sodium levels compared to many other cheeses, making it a heart-friendly option when consumed in moderation (via [Healthline](https://www.healthline.com)).

Plus, per [WebMD](#), evidence suggests that it contains compounds with blood pressure-lowering properties, meaning that its heart-healthy effects might be even broader (again, when consumed in moderate amounts). Yet, keep in mind that it still boasts a high saturated fat content, which is something to consider if you're keeping an eye on your cholesterol levels. Regarding its culinary uses, Swiss cheese is highly versatile. Due to its unparalleled melting capacity, the cheese is a staple in grilled cheese sandwiches and fondues or casseroles. It also shines on charcuterie boards, as it pairs nicely with deli meats like prosciutto,

fruits, and nuts.

## Blue Cheese



Top view of blue cheese on wooden cutting board© Istetiana/Getty Images

While mold in food usually signals that an item is past its prime, this is certainly not the case for blue cheese, as this specific type of mold is not toxic. Blue cheese gets its distinctive blue or green moldy streaks by adding *Penicillium roqueforti* mold mixed with milk during the cheese-making process, resulting in a cheese with a sharp and salty flavor (via [Medical News Today](#)). The cheese, which can be made with cow's, goat's, or sheep's milk, is a good source of calcium and phosphorus, with a one-cup serving of crumbled blue cheese packing 55% and 42% of the DV of each (per the [USDA Food Data Central](#)). This makes it a beneficial food item for bone and teeth health. Additionally, blue cheese also contains vitamin K, which, according to a [review](#) published in *Mini-Reviews in Medicinal Chemistry*, plays a role in bone metabolism and blood coagulation.

Despite its nutritional benefits, blue cheese has its own disadvantages. For instance, while blue cheese's mold is non-toxic, it can produce toxic compounds once the cheese begins to spoil, leading to symptoms that might range from mild and short-lived to severe and long-lasting. Regarding its culinary applications, blue cheese adds a contrasting flavor to dishes ranging from salads to burgers. It also pairs well with fruits like pears, figs, apples, nuts, and honey, which is why it often finds its way into charcuterie boards.

## Parmesan Cheese



Shredded parmesan next to parmesan wedge© Veni Vidi...shoot/Getty Images

Parmesan cheese is an Italian golden and hard yet brittle cheese that's aged for long periods of time, granting it its distinctive umami flavor. Like most cheeses, parmesan cheese is a good source of protein. However, according to an [article](#) published in Food Technology and Biotechnology, proteins in parmesan not only provide all essential amino acids, but they're also relatively easy to digest thanks to the cheese's long aging process. The article explains that during ripening, proteins in parmesan get hydrolyzed or broken down into smaller particles, a process that would be similar to pre-digestion, making it easier for the body to assimilate.

Plus, the cheese's fat composition provides it with healthy fatty acids, including CLA and MCFAs. Lastly, it also explains that parmesan is a virtually lactose-free cheese, making it an ideal option for [people with lactose intolerance](#). Being the

quintessential Italian ingredient, parmesan cheese is commonly grated over Italian classics like pasta or soup. You might also enjoy it shaved over salads, carpaccios, and pizzas. Whether used as a finishing touch or a primary ingredient, parmesan cheese will surely enhance the flavor of numerous dishes.

## Gouda Cheese



Traditional wheels of Gouda cheese© Tim Graham/Getty Images

Named after the town of Gouda in Holland, this cow's milk cheese is available in a broad range of textures and flavors, all of which depend upon the length of its aging process (via [Nutrition Advance](#)). For instance, gouda cheese that has been aged for merely a month tends to be softer and milder in flavor. In contrast, when aged for over a year, the cheese develops a bolder taste, and its texture becomes more firm. Nevertheless, all gouda varieties have in common that they're produced using unpasteurized milk, meaning that the friendly bacteria (probiotics) present in the milk still remain in the end product. Probiotics help improve gut health by balancing the bacterial environment in your gut, which plays a key role in metabolism and overall health (per [Harvard Health Publishing](#)).

However, gouda's fat content can be high, which might pose concerns for those managing their fat intake, and it is not a good option for those following a lactose-free diet. Once again, when it comes to cooking with gouda, its uses vary depending on the type of gouda you choose. Softer varieties melt smoothly and



are perfect for casseroles and other baked or grilled dishes. On the other hand, aged gouda works best in cheese boards or salads.

## **Better Bone Health: Top Calcium-Rich Foods That Aren't Dairy**

Getting enough calcium is vital for strong bones and overall health, but you don't need to rely on dairy to meet your needs! Many non-dairy foods are packed with calcium and offer a variety of flavors and textures to enjoy. Below is a list of 15 fantastic non-dairy sources of calcium, each with its unique benefits. Whether you're vegan, lactose intolerant, or simply looking to diversify your diet, these calcium-rich foods can help you reach your needs!

### **White Beans**

White beans are a versatile legume that's easy to add to soups, stews, and salads. A single cup of cooked white beans provides about 161 mg of calcium, along with protein and fiber to keep you full and satisfied. They also support heart health by lowering cholesterol and stabilizing blood sugar levels.

### **Dried Figs**

Dried figs are a sweet and chewy snack that packs a surprising punch of calcium. Just about eight figs, or 1 cup, provides 241 mg of calcium, making them a great option for maintaining bone health. They're also rich in fiber and antioxidants, promoting digestive health and fighting off free radicals in the body.

### **Tofu**

Tofu is an excellent plant-based source of calcium, especially when it's made with calcium sulfate. Half a cup of tofu can contain up to 861 mg of calcium, depending on how it's prepared. It's also a great [non-meat source for protein](#), making it perfect for those following a vegetarian or vegan diet.

### **Kale**

Kale is more than just a trendy [leafy green](#); it's also packed with calcium. A single cup of cooked kale delivers about 177 mg of calcium, along with vitamins A, C, and K, while just 2 cups of raw chopped kale provide about 180 mg of calcium. This leafy green supports bone health and has anti-inflammatory properties, making it a great addition to your diet.

## Sweet Potatoes

Sweet potatoes are not only delicious but also a good source of calcium and [healthy carbs](#), with about 68 mg in a medium-sized baked potato. They're also rich in beta-carotene, which is essential for eye health, and fiber, which aids digestion. Sweet potatoes help keep you full and energized throughout the day. You can enjoy it on its own or make a [sweet potato toast!](#)

## Okra

Okra is a nutrient-dense vegetable that's often overlooked. A cup of cooked okra provides about 88 mg of calcium, along with vitamins C and K, fiber, and antioxidants. It's particularly good for supporting bone health and promoting a healthy digestive system.

## Oranges

Oranges are widely known for their vitamin C content, but they also offer a decent amount of calcium. One large orange contains about 74 mg of calcium, along with potassium, fiber, and antioxidants. Eating oranges can [boost immunity](#) and support heart health.

## Arugula

Arugula is a leafy green with a peppery flavor and plenty of calcium. A cup of raw arugula provides about 32 mg of calcium, making it a tasty addition to salads, [chicken sandwiches](#), and pizzas. Arugula is also rich in vitamins A and K, which are essential for bone health and eye function.

## Almonds



Almonds are a crunchy snack that's rich in calcium, with about 385 mg in one cup. They also offer healthy fats, protein, and fiber, making them great for heart health and keeping you full between meals. Almonds are also beneficial for maintaining healthy skin and hair.

## **Sunflower Seeds**

Sunflower seeds are a nutrient-packed snack that's rich in calcium, providing about 109 mg per cup. They're also high in vitamin E, magnesium, and healthy fats, which support heart health and reduce inflammation. Adding sunflower seeds to your diet can also help improve skin health and boost your immune system.

## **Bok Choy**

Bok choy, also known as Chinese cabbage, is a leafy green vegetable that's packed with calcium. One cup of cooked bok choy contains about 158 mg of calcium. It's also rich in vitamins A, C, and K, making it great for boosting immune function and supporting healthy skin.

## **Broccoli**

Broccoli is a popular vegetable that's high in calcium, with about 62 mg per cup of cooked broccoli. It's also packed with vitamins C and K, as well as fiber and antioxidants. Broccoli supports bone health, aids digestion, and has anti-inflammatory properties.

## **Collard Greens**

Collard greens are another leafy green that's rich in calcium, providing about 84 mg per cup of cooked greens. They're also high in vitamins A, C, and K, as well as fiber and folate. Collard greens are particularly beneficial for bone health and reducing the risk of osteoporosis.

## **Nourish Your Mind: 15 Foods for Optimal Brain Health**

Your brain is a powerful organ that controls everything your body does, so it's important to keep it healthy. Eating the right foods can help improve brain function, boost memory, and protect against cognitive decline.

Here are 15 foods that can nourish your mind and support optimal brain health.

### **Blueberries**

Blueberries are packed with antioxidants that protect the brain from oxidative stress. These tiny berries can improve memory and cognitive function. They are also known to delay brain aging and fight neurodegenerative diseases.

Add them to your breakfast cereal, smoothies, or enjoy them as a snack. Regular consumption of blueberries can help keep your brain sharp.

### **Fatty Fish**

Fatty fish like salmon, trout, and sardines are rich in omega-3 fatty acids, which are crucial for brain health. Omega-3s help build brain and nerve cells, essential for learning and memory.

They also have anti-inflammatory properties that protect the brain. Aim to eat fatty fish at least twice a week. If you don't eat fish, consider omega-3 supplements.

### **Turmeric**

Turmeric contains curcumin, a compound with powerful anti-inflammatory and antioxidant benefits. Curcumin can cross the blood-brain barrier, enhancing brain health.

It has been shown to improve mood, reduce depression symptoms, and boost brain-derived neurotrophic factor (BDNF). Add turmeric to your cooking or enjoy a turmeric latte. Regular intake can help support cognitive function.

## **Broccoli**

Broccoli is a superfood packed with antioxidants and vitamin K, which is essential for brain health. Vitamin K helps strengthen cognitive abilities and supports the formation of sphingolipids, a type of fat found in brain cells.

Broccoli also contains compounds that have anti-inflammatory and antioxidant effects. Include broccoli in your salads, stir-fries, or as a side dish.

## **Pumpkin Seeds**

Pumpkin seeds are rich in magnesium, iron, zinc, and copper, all of which are vital for brain health. Magnesium is crucial for learning and memory, while zinc and copper support nerve signaling.

Iron helps prevent cognitive decline and brain fog. For a brain-boosting treat, snack on a handful of pumpkin seeds or add them to salads and yogurt.

## **Dark Chocolate**

Dark chocolate with high cocoa content is packed with flavonoids, caffeine, and antioxidants. Flavonoids in chocolate improve blood flow to the brain and enhance memory and learning.

Dark chocolate also stimulates the release of endorphins, improving mood. Enjoy a small piece of dark chocolate daily. It's a delicious way to boost brain health.

## **Nuts**

Nuts like almonds, walnuts, and hazelnuts are excellent for brain health. They are rich in healthy fats, antioxidants, and vitamin E, which protects cells from oxidative stress.

Walnuts are particularly high in DHA, a type of omega-3 fatty acid that boosts brain function. Incorporate a variety of nuts into your diet as snacks or in salads and dishes.

## **Oranges**

Oranges are a great source of vitamin C, which is crucial for preventing mental decline. Vitamin C helps protect the brain against damage from free radicals. It also supports brain health by maintaining neurotransmitter function.

Eating one medium-sized orange a day can provide the recommended daily dose of vitamin C. Enjoy oranges fresh, or add them to salads and smoothies.

## **Eggs**

Eggs are rich in several nutrients tied to brain health, including vitamins B6 and B12, folate, and choline. Choline is important for the production of acetylcholine, a neurotransmitter that helps regulate mood and memory.

B vitamins help slow the progression of mental decline. Include eggs in your diet by having them for breakfast or adding them to salads and dishes.

## **Green Tea**

Green tea contains caffeine and L-theanine, which can improve brain function. The combination of these two compounds boosts memory, increases focus, and enhances cognitive performance. Green tea is also rich in antioxidants that protect the brain.

Enjoy a cup of green tea daily to reap its brain-boosting benefits. It's a simple addition to your routine that can support mental clarity.

## **Avocados**

Avocados are rich in healthy monounsaturated fats that support brain health. These fats help improve blood flow to the brain and reduce blood pressure. Avocados also contain vitamin K and folate, which protect against cognitive decline.

Add avocado to your meals, such as salads, toast, or smoothies. It's a creamy, nutritious way to support brain function.

## **Spinach**

Spinach is loaded with antioxidants, vitamins, and minerals that benefit the brain. It's high in lutein, folate, and beta-carotene, which help prevent cognitive decline.

Spinach also provides vitamin K, essential for brain function. Include spinach in your diet by adding it to salads, smoothies, and cooked dishes. Its nutrient density makes it a powerful brain food.

## **Whole Grains**

Whole grains like oats, quinoa, and brown rice provide a steady supply of glucose to the brain. They are rich in fiber, which helps regulate blood sugar levels and maintain mental alertness.

Whole grains also contain B vitamins, which support brain health. Choose whole-grain bread, cereals, and side dishes to incorporate whole grains into your meals.

## **Tomatoes**

Tomatoes are high in lycopene, an antioxidant that protects brain cells from damage. Lycopene has been linked to a reduced risk of stroke and Alzheimer's disease. Tomatoes also provide vitamins A and C, which support overall brain health.

Add tomatoes to your salads, sauces, and sandwiches. Their vibrant color and flavor make them a versatile and healthy addition to your diet.

## **Beans**

Beans are an excellent source of protein, fiber, and essential nutrients like folate and magnesium. Folate is crucial for brain function and emotional well-being, while magnesium supports nerve signaling.

Beans also provide a steady source of energy to the brain. Include a variety of beans in your meals, such as in soups, salads, and stews. They are a nutritious and affordable way to support brain health.

## **10 Side-Effects Of Consuming Too Much Sugar & Why You Should Lower Your Intake**

### **1. Weight Gain**

Excessive sugar intake, particularly added sugars, can cause significant weight gain. Thanks to the high calories and low fiber, it's easy to overconsume sugary foods and drinks, often leading to a few extra pounds.

### **2. Type 2 Diabetes**

Too much sugar puts you on the fast track to all sorts of health risks, namely type 2 diabetes. Overconsumption can lead to insulin resistance, which may trigger higher blood sugar levels that develop into type 2 diabetes.

### **3. Tooth Decay**

It turns out our parents (and dentists) weren't lying about sugar and oral health. In fact, too much sugar is one of the quickest ways to erode enamel and produce harmful bacteria in the mouth. You're also more susceptible to cavities.

### **4. Risk of Heart Disease**

High-sugar diets can wreak havoc on your ticker, leading to an increased risk of heart disease. Due to health concerns like inflammation or high blood pressure, too much sugar can affect the heart and leave you prone to much larger issues.

### **5. Inflammation**



Speaking of health risks, overconsuming sugar can cause chronic inflammation if you're not careful. Untreated, and persistent, inflammation has been linked to an onslaught of health conditions such as cancer and arthritis.

## **6. Mental Health Risks**

As if the physical risks weren't enough, too much sugar affects mental health as well. The sad truth is that high-sugar diets have been linked to greater risks of depression and anxiety on account of blood sugar spikes and lower energy levels.

## **7. Low Energy**

Sugar is great at tricking us into thinking it provides energy—and it's because it technically does, but only for a short time. After that little pick-me-up, don't be surprised if you go through the dreaded sugar crash, zapping all your energy and leaving you worse for wear throughout the day.

## **8. High Blood Pressure**

Until now, we all thought excessive sodium led to high blood pressure (which it does), but sugar is just as big a culprit. Too much sugar has been known to increase blood pressure levels, impeding kidney function and putting undue pressure on the blood vessels.

## **9. Fatty Liver**

Fatty liver disease quite literally means fat in the liver, and it often comes from excessive calories or sugar intake. Though it's not guaranteed, overconsuming sugar, especially fructose, does put you at a greater risk of developing it.

## **10. Digestion Issues**

We've all been there—one moment we're eating a handful of gummy worms and the next our stomachs start rumbling. As tasty as it is, it's because sugar leads to all kinds of digestive problems like bloating, gas, and diarrhea. It's

even worse for those with IBS. Now that we know why too much sugar is bad for you, let's dive into why less sugar is good for you.

## **11. Healthier Skin**

Low-sugar diets can help achieve that healthy glow you're after. The reason why is that less sugar keeps skin proteins protected, warding off early signs of aging and potentially protecting against acne, too.

## **12. Improved Heart Health**

We now know what too much sugar does to the heart, so imagine how healthy our tickers can be with a better diet. Low-sugar diets reduce the risk of heart disease, reduce inflammation, and help regulate blood pressure.

## **13. Weight Management**

We wish it weren't so, but less sugar in the diet means fewer inches around the waist. Proper calorie deficits can lower sugar consumption and put you on the fast track to better health. Swapping out high-sugar foods for nutrient-dense ones gives you more of what you actually need.

## **14. Better Immune Function**

Another surprising benefit of less sugar is you can also boost white blood cell function. Studies have shown that reducing sugar improves our immune system, which we'd obviously like working at full capacity.

## **15. Easy to Control**

People sometimes mistake healthier diets for bland, boring meals that are not only expensive but hard to make. The thing is, though, that better meals don't have to cost an arm and a leg—they keep you fuller for longer, too, which means less reaching for the cookie jar.

## **16. Fewer Health Risks**

With a stronger heart and better immune system, it's easy to see why the body thrives with less sugar. But that's not all you have to look forward to! Low-sugar diets also lower cancer risks, improve liver function, and regulate cholesterol levels (among other benefits).

## **17. Better Nutrition**

Lean meats, fatty fish, and leafy greens have far more health benefits than a cake slice. Consistently incorporating nutrient-dense foods into your diet ensures you have all the vitamins and minerals necessary for a longer, healthier life.

## **18. More Energy**

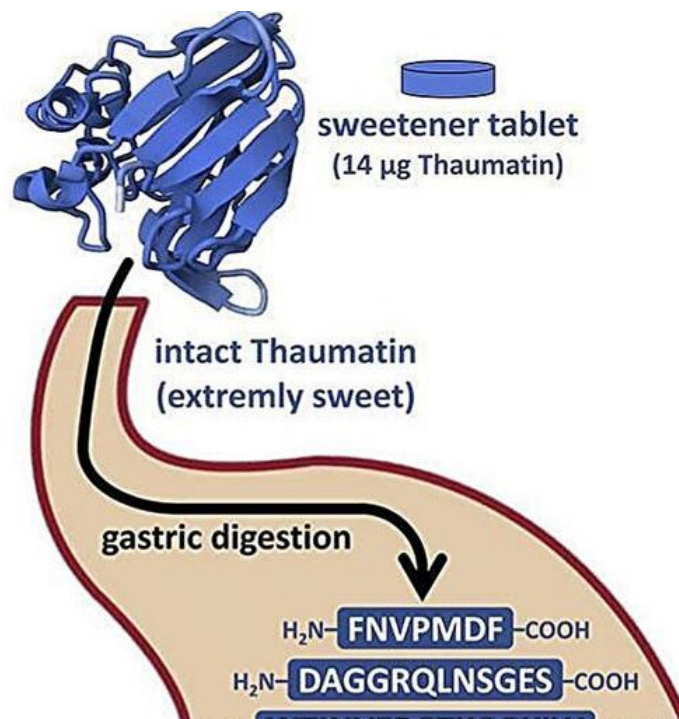
Put down that pastry—there are healthier alternatives that give an actual energy boost! Eggs, nuts, avocados, and sardines are just a few of the foods that keep you energized all day long. They're also packed with additional vitamins and nutrients.

## **19. Better Mood**

Forget the fleeting joy of sugary foods and drinks. Regular exercise and a healthy diet are the perfect combo for strong mental health, often stabilizing moods and leading to a lower risk of mental health concerns.

## **20. Reduced Cravings**

The right diet keeps you fuller for longer, which means you can nip those cravings in the bud. Turn to potatoes, eggs, oatmeal, or quinoa for enriching meals that actually fill your belly.



Graphical abstract. Credit: Food Chemistry (2024). DOI: 10.1016/j.foodchem.2024.139157

A new study by the Leibniz Institute for Food Systems Biology at the Technical University of Munich shows for the first time that bitter tasting protein fragments (peptides) are produced in the stomach during the digestion of the natural sweetener thaumatin.

In a cellular test system, the peptides are able to stimulate the acid secretion of human stomach cells and influence inflammatory reactions. "Our research helps to elucidate the health effects of the plant protein, which is widely used as a sweetener," says Veronika Somoza, head of the study and director of the Leibniz Institute.

Taste receptors for bitter are not only found on the tongue, but also on the surface of other tissues and cells. These include the parietal cells of the stomach, which secrete protons into the stomach—i.e., produce stomach acid.

Somoza's team is researching, among other things, how bitter-tasting food compounds influence the metabolism of stomach cells and thus health. To this end, the team established a human gastric cell line (HGT-1 cells) as a test system.

In earlier studies, the scientists had already shown that certain bitter substances interact with the stomach cells' own bitter taste receptors to stimulate the release of protons and thus the acid production of the cells. Such bitter substances also include peptides produced during the digestion of milk protein.

## Building on earlier findings

"However, not only bitter tasting substances, but also the health effects of sweeteners are always in the focus of public interest. Based on our earlier findings, we therefore investigated whether bitter tasting peptides are also formed from the sweet tasting protein thaumatin in the stomach, which could have a physiological effect," reports Phil Richter, first author and doctoral student at the Leibniz Institute.

Using studies on pigs, in vitro experiments and sensory tests, the team first identified three peptides that are produced during the digestion of thaumatin in the stomach and have a bitter taste.

The paper is [published](#) in the journal *Food Chemistry*. The study was conducted by the Leibniz Institute for Food Systems Biology at the Technical University of Munich in cooperation with the Technical University of Munich (TUM).

In the test system, the bitter peptides stimulated the release of protons from HGT-1 cells even at extremely low concentrations, i.e., in the nanomolar range. One nanomole corresponds to one billionth of a mole, i.e., an extremely small amount of a substance. One mole of a substance corresponds to approx.  $6 \times 10^{23}$  particles.

In order to find out more about the potential anti-inflammatory effect of the three peptides, the team first investigated how the stomach cells of the test system generally react to the addition of *Helicobacter pylori* proteins.

The bacterium *H. pylori* can cause inflammatory stomach diseases and even stomach cancer. Around half of the world's population is infected with this pathogen. In contrast to many other bacteria, it is able to survive in an extremely acidic stomach environment by neutralizing the low pH value of stomach acid, among other things.

## Anti-inflammatory effect

As the team's test results show, *H. pylori* proteins induce an increased release of pro-inflammatory interleukin 17A in the test cells. "It is interesting that we were able to reduce the induced interleukin release of the gastric cells by up to 89.7% by adding one of the identified bitter tasting peptides. The gastric cell's own bitter taste receptor TAS2R16 was involved in this anti-inflammatory effect and also in the stimulation of proton release," reports Richter.

"The peptide concentrations tested in our study are based on realistic concentrations that can be achieved in the stomach by eating a commercially available sweetener tablet. Therefore, our results suggest that the anti-inflammatory potential of thaumatin or its bitter cleavage products as well as the functions of endogenous bitter taste receptors should be further investigated.

"Our aim is to better understand the molecular mechanisms of diet-related inflammatory gastric diseases. Not least with regard to infections with *Helicobacter pylori*," explains Somoza.

## Thaumatococcus characteristics

Thaumatococcus is a protein that occurs naturally in the West African Katemfe fruit. It has long been known for its sweetening properties and also has a flavor-enhancing effect. As an EU-approved sweetener (E 957), it is frequently used in foods and drinks.

Due to its intense sweetening power, which is around 1,600 times that of sucrose (household sugar), the daily intake by humans is rather low and its energy content of around four kilocalories per gram can be disregarded. A disadvantage, however, is that thaumatococcus loses its sweetening power when baked and cooked. However, heat does not impair its flavor-enhancing effect.

No ADI value has been set for thaumatococcus, as the body breaks down the protein completely. Even high intakes are considered toxicologically safe. The ADI (Acceptable Daily Intake) is the amount of a substance that a person can consume daily over a lifetime without fear of adverse health effects.



**More information:** Phil Richter et al, Gastric digestion of the sweet-tasting plant protein thaumatin releases bitter peptides that reduce H. pylori induced pro-inflammatory IL-17A release via the TAS2R16 bitter taste receptor, *Food Chemistry* (2024). DOI: [10.1016/j.foodchem.2024.139157](https://doi.org/10.1016/j.foodchem.2024.139157)

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## Medicinal Mushrooms: Their Bioactive Components, Nutritional Value and Application in Functional Food Production—A Review

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### Abstract

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Medicinal mushrooms, e.g., Lion's Mane (*Hericium erinaceus* (Bull.) Pers.), Reishi (*Ganoderma lucidum* (Curtis) P. Karst.), Chaga (*Inonotus obliquus* (Ach. ex Pers.) Pilát), Cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora), Shiitake (*Lentinula edodes* (Berk.) Pegler), and Turkey Tail (*Trametes versicolor* (L.) Lloyd), are considered new-generation foods and are of growing interest to

consumers. They are characterised by a high content of biologically active compounds, including (1,3)(1,6)- $\beta$ -D-glucans, which are classified as dietary fibre, triterpenes, phenolic compounds, and sterols. Thanks to their low-fat content, they are a low-calorie product and are classified as a functional food. They have a beneficial effect on the organism through the improvement of its overall health and nutritional level. The biologically active constituents contained in medicinal mushrooms exhibit anticancer, antioxidant, antidiabetic, and immunomodulatory effects. In addition, these mushrooms accelerate metabolism, help fight obesity, and slow down the ageing processes thanks to their high antioxidant activity. The vast therapeutic properties of mushrooms are still not fully understood. Detailed mechanisms of the effects of medicinal mushrooms on the human organism still require long-term clinical studies to confirm their nutraceutical effects, their safety of use, and their dosage. Medicinal mushrooms have great potential to be used in the design of innovative functional foods. There is a need for further research on the possibility of incorporating mushrooms into food products to assess the interactions of their bioactive substances with ingredients in the food matrix. This review focuses on the properties of selected medicinal mushrooms and their effects on the human organism and presents current knowledge on the possibilities of their use in the production of functional foods.

**Keywords:** medicinal mushrooms, bioactive compounds, polysaccharides, functional foods, nutraceuticals, new generation foods, (1,3)(1,6)- $\beta$ -D-glucans, polyphenols, antioxidant activity

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## 1. Introduction

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For many years, mushrooms have accompanied humans both as food and medicine. Data from the literature indicate that, with the onset of hunting, mushrooms began to play an important role in the human diet [1]. Fruiting bodies, i.n., the visible part above the substrate commonly referred to as the mushroom, are the edible elements of some

filamentous fungi [2]. Fungi form a separate kingdom alongside the kingdoms of prokaryotes, eukaryotes, plants, and animals [3]. About 2.2–3.8 million species of fungi in the world have been identified, of which 150,000 species have been described, 2000 species are considered edible, and over 200 species of wild mushrooms are considered medicinal [4,5]. Edible mushrooms, unlike medicinal mushrooms, are mainly consumed as fresh mushrooms with fruiting bodies or dried products. They can also be consumed as boiled, fried, roasted, soups, tinctures, teas, and many different dishes, while medicinal mushrooms are mostly used in biopharmaceutical applications in powdered, loose, or liquid extract forms [6]. In culinary terms, mushrooms are wrongly classified as vegetables and are informally categorised as ‘white vegetables’ [7]. According to the USDA (United States Department of Agriculture), they can be used as a substitute for vegetables in the diet at a ratio of 1:1 (USDA, 2022). Due to their content of biologically active compounds with beneficial health effects, medicinal mushrooms have been used worldwide in folk medicine for centuries. They are particularly popular in Asian countries, e.g., China, Japan, Taiwan, and Korea. Due to the presence of numerous biologically active compounds, including polysaccharides, proteins, peptides, terpenoids, polyphenols, vitamins, and mineral elements, they are ascribed, e.g., anti-cancer, anti-inflammatory, antioxidant, hypocholesterolemic, hypoglycaemic, and immunomodulatory effects [8,9]. However, it should be remembered that the consumption of medicinal mushrooms is not always advisable. The safety of their use during pregnancy, lactation, and in children is still poorly reported. The selected bioactive compounds found in mushrooms may potentially limit the absorption of nutrients, trace elements, and vitamins. As a result, it is recommended that the elderly and children avoid the excessive consumption of mushrooms. Additionally, individuals taking medications or herbs should exercise caution when using mushrooms due to the potential for interactions with their bioactive compounds.

The chemical profile of medicinal mushrooms varies according to species, strain, cultivation conditions (cultured or growing wild) [10], the degree of maturity [11], and the proportion of individual anatomical

parts in the total mass of the mushroom [12]. This is largely determined by environmental (access to water, light, UV radiation) [9,13] and biological (type of substrate/host, presence of competing fungi) factors. Song et al. [8] compared the chemical composition and functional properties of wood-cultured and sack-cultured Shiitake (*Lentinula edodes* (Berk.) Pegler) and proved that the wood-cultured fungus had a higher content of terpenoids and phenolic components and concurrently exhibited higher antioxidant and hypoglycaemic potential compared to the sack-cultured Shiitake (*Lentinula edodes* (Berk.) Pegler). In the case of Chaga (*Inonotus obliquus* (Ach. ex Pers.) Pilát), which is a parasite of various deciduous trees, only sclerotia derived from birch trunks have contained tree-specific compounds (betulin and betulinic acid) showing anticarcinogenic activity. Equally great importance for the chemical composition and health-promoting potential of medicinal mushrooms is ascribed to the world region from which they originate [14,15]. Chaga (*Inonotus obliquus* (Ach. ex Pers.) Pilát) sclerotia collected in France, Ukraine, and Canada were characterised by their different contents of betulin, betulinic acid, and inotodiol and showed differential biological activity in different cancer cells [15]. The bioactive substances present in fungi are primary and secondary metabolites that can be synthesised in response to specific environmental stimuli [9,13]. Their content depends on the species of fungus and their growing conditions [10,16]. However, Peng and Shahidi [17] emphasise that the cultivation of medicinal mushrooms in standard conditions offers the possibility to stimulate the synthesis of selected biologically active substances and yields raw materials with a reproducible chemical composition, comparable biological effects, and greater health safety (with a lower content of heavy metals, which are often found in excess in wild mushrooms growing in polluted environments).

The existence of a huge number of medicinal mushroom species with their diverse chemical composition and content of biologically active compounds and thus multidirectional effects on the human organism could make mushrooms objects of growing consumer interest. In 2020, the size of the global mushroom market was 14.35 million tonnes; it is estimated to grow to 24.05 million tonnes in 2028. The most popular

mushrooms among consumers include Reishi (*Ganoderma lucidum*), Lion's Mane (*Hericium erinaceus*), Chaga (*Inonotus obliquus* (Ach. ex Pers.) Pilát), Turkey Tail (*Trametes versicolor* (L.) Lloyd)), Shiitake (*Lentinula edodes* (Berk.) Pegler), and Cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora prior name *Cordyceps sinensis*). It is, therefore, expedient to compile and systematise existing knowledge on the most popular medicinal mushrooms, compare their functional potential, and discuss the possibilities of their use in the food industry.

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## 2. Nutritional Value and Bioactive Components

Due to their high-water content (about 80–90%), the fruiting bodies of medicinal mushrooms are low in calories (50–70 kcal/100 g) [18]. After drying, their moisture content is at the level of about 3–13% [12,19,20]. The chemical composition of medicinal mushrooms is shown in Table 1. These mushrooms are a source of such nutrients as carbohydrates (65.6–87.13% d.b.), dietary fibre (16–53% d.b.), protein (3.87–37.4% d.b.), minerals (6.2–9.7% d.b.), and fats (1–5.62% d.b.) [21].

Table 1

The chemical composition of medicinal mushrooms (g/100 g dried mushrooms).

| Common Name | Latin Name                                     | Moisture  | Protein   | Carbohydrates | Lipids | Dietary Fibre | Ash  | The Literature Source |
|-------------|------------------------------------------------|-----------|-----------|---------------|--------|---------------|------|-----------------------|
| Reishi      | <i>Ganoderma lucidum</i> (Curtis) P. Karst.    | 7.5–12.99 | 13.3–23.6 | 42.8–82.3     | 3–5.8  | 14.81         | 4    | [19,22,23]            |
| Lion's Mane | <i>Hericium erinaceus</i> (Bull.) Pers.        | 7.03 *    | 22.3      | 57.0          | 3.5    | 3.3–7.8       | 7.1  | [19,23]               |
| Chaga       | <i>Inonotus obliquus</i> (Ach. ex Pers.) Pilát | 3.5       | 2.4       | 10.3          | 1.7    | 67.5          | n.d. | [20]                  |

| Common Name                                                                   | Latin Name                                                                                                          | Moisture | Protein    | Carbohydrates | Lipids    | Dietary Fibre                                  | Ash       | The Literature Source |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------|------------|---------------|-----------|------------------------------------------------|-----------|-----------------------|
| Cordyceps                                                                     | <i>Ophiocordyceps sinensis</i> (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora<br><i>Cordyceps sinensis</i> | 3.5 *    | 21.9–23.1  | 24.2–49.3     | 5.5–8.2   | 7.7                                            | 13.13     | [19,23]               |
| Shiitake                                                                      | <i>Lentinula edodes</i> (Berk.) Pegler                                                                              | 7.14     | 17.2–27.09 | 38.1–66.0     | 1.26–2.95 | 46.19–49.09 (IDF: 40.7–44.2 and SDF: 1.95–8.4) | 6.05–6.73 | [24,25,26,27]         |
| Turkey Tail<br>It also known as;<br>Cloud mushroom,<br>Yun Zhi,<br>Kawaritake | <i>Trametes versicolor</i> (L.) Lloyd                                                                               | -        | 11.07      | -             | 1.35      | -                                              | -         | [28]                  |

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(-)—no data; (\*)—unpublished own research, IDF—water-insoluble dietary fibre, SDF—water-soluble dietary fibre.

## 2.1. Polysaccharides

Carbohydrates present in fungi are represented by monosaccharides (glucose, fructose, galactose), alcohol sugars (mannitol), oligosaccharides



(trehalose, malezitose), and polysaccharides, among which homopolysaccharides (glucans, chitin, glycogen) and heteropolysaccharides (xylomannan,  $\alpha$ -(1 $\rightarrow$ 4)-D-glucopyranosyl and  $\beta$ -(1 $\rightarrow$ 6)-D-galactopyranosyl with branches at *O*-6 of glucose and *O*-2 of galactose, 6-*O*-galactopyranoses substituted at *O*-2 by 3-*O*-D-mannopyranosyl-L-fucopyranosyl,  $\alpha$ -D-mannopyranosyl, and  $\alpha$ -L-fucopyranosyl,  $\alpha$ -(1 $\rightarrow$ 3)-linked galactose, with  $\beta$ -(1 $\rightarrow$ 4),(1 $\rightarrow$ 6)-glucose and fucose branches, mucilage composed of glucose and galactose can be distinguished). Carbohydrates can also occur in complexes with other compounds (e.g., proteins) and may include various sugar subunits [29,30,31]. Depending on their structure, bond type, and molecular weight, carbohydrates have different functional properties. The main indigestible polysaccharides present in fungi are chitin and  $\beta$ -D-glucans. They are composed of sugar units that are linked by  $\beta$ -glycosidic bonds. The monomer in chitin is  $\beta$ -glucosamine and is linked by 1-4- $\beta$ -glycosidic bonds, while  $\beta$ -glucans are made up of glucopyranose molecules. The molecules linked by  $\beta$ -(1,3) and  $\beta$ -(1,4) glycosidic bonds form linear segments to which side chains are attached via  $\beta$ -(1,6) glycosidic bonds [29]. These compounds are classified as dietary fibres. They are found in fungal fruiting bodies and in fungal cells at both the vegetative and generative stages of ontogenesis and play a structural role in co-forming cell walls. A special physiological role is attributed to  $\beta$ -D-glucans and complexes of these compounds with proteins [32,33].

Their structure takes the form of a single helix, a triple helix, or a random helix. Depending on their molecular weight, the type of  $\beta$ -glycosidic bonds present in the molecule, and the chain conformation, these compounds exhibit different functional properties [34]. Beta-glucans with a triple helix structure show a greater ability to inhibit tumour growth than  $\beta$ -glucans in a single helix form [35]. As reported by Sletmoen and Stokke [36] and Brown and Gordon [37], compounds with a higher molecular weight and lower water solubility are more potent immunostimulators, while  $\beta$ -glucans with a low MW and a short side chain are considered less active. On the contrary, Rop et al. [34] found that water-soluble  $\beta$ -glucans had stronger immunomodulatory properties than water-insoluble  $\beta$ -glucans. Macrophages mainly act as

antigen-presenting immune cells, which contribute to the immunomodulatory effect of  $\beta$ -glucans by stimulating the fight against bacteria and viruses. High molecular weight molecules stimulate the action of specific lymphocyte—NK cells, which show cytotoxic effects against tumour cells.

In addition, they upregulate the expression of cytokines that are associated with immune response, including interferon- $\gamma$ , TNF- $\alpha$ , IFN-g, IL-1, and IL-12, which inhibit tumour cell proliferation and induce their apoptosis, thereby exerting anti-tumour, antibacterial, and antiviral effects [23,37,38]. These compounds are often used as adjuvants in traditional cancer chemotherapy [39,40,41,42,43,44].

The content of  $\beta$ -glucans in mushrooms varies between 3.79% d.b. for Cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora) and 60.79% d.b. for Turkey Tail (*Trametes versicolor* (L.) Lloyd) (Table 2) [44,45]. In general, edodes are a better source of these compounds than caps. The Shiitake (*Lentinula edodes* (Berk.) Pegler) mushroom is a rich source of  $\beta$ -glucans [34]. It takes its specific name from its  $\beta$ -glucan lentinan, which stimulates immune cells to attack cancer cells. Lentinan enhances the production of T lymphocytes and can potentiate the effect of AZT (3'-Azido-3'-deoxythymidine) in the anti-viral treatment of AIDS [27]. Its positive effects have been proved in the treatment of, e.g., glioma (human astrocytoma U251 cells) [46], breast cancer [47] and liver cancer [48]. In turn, the Turkey Tail (*Trametes versicolor* (L.) Lloyd) contains characteristic proteoglucans. One of these is crestin, also known as polysaccharide-K (PSK), which contains about 25–38% of the protein in the molecule. This proteoglucan is effective in the treatment of, e.g., gastric, oesophageal, colon, rectal, and lung cancer [29].

## Table 2

Beta-glucan content of different medicinal mushrooms [31,44,48].

| Common Name        | Latin Name                                                                                                                  | Content of $\beta$ -Glucans (g/100 g d.b.) |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| Reishi             | <i>Ganoderma lucidum</i> (Curtis) P. Karst.                                                                                 | 4.3–23.6                                   |
| Lion's Mane        | <i>Hericium erinaceus</i> (Bull.) Pers.                                                                                     | 35.3                                       |
| Chaga              | <i>Inonotus obliquus</i> (Ach. ex Pers.) Pilát                                                                              | 8.5                                        |
| Shiitake cap/steam | <i>Lentinula edodes</i> (Berk.) Pegler                                                                                      | 20.0/25.3                                  |
| Turkey tail        | <i>Trametes versicolor</i> (L.) Lloyd                                                                                       | 60.79                                      |
| Cordyceps          | <i>Ophiocordyceps sinensis</i> (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora prior name <i>Cordyceps sinensis</i> | 3.79                                       |

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Another type of glucan that is complexed with protein present in Turkey Tail (*Trametes versicolor* (L.) Lloyd) mushrooms is called PSP (Poly Saccharo Peptide) and activates immune cells by increasing the production of cytokines, chemokines, histamine, and prostaglandin E. It reduces the detrimental effects of chemotherapy by alleviating fatigue, loss of appetite, vomiting, a dry mouth, and other related discomforts [49]. In addition to  $\beta$ -glucans, biological activity has also been attributed to poly- and monosaccharides occurring in complexes with other compounds. An example is the cordycepin present in cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones, and Spatafora). Its chemical structure resembles that of the nucleoside adenosine (ribose + adenine sugar); however, it lacks one hydroxyl group at position three of the five-membered ring of the ribose moiety. Adenosine is involved in DNA and/or RNA synthesis in cells. Thanks to its analogy to adenosine, cordycepin can build into the RNA and DNA structures of bacteria and viruses and interfere with the biosynthesis and modification of nucleic acids, thereby limiting the growth of these microorganisms. It increases the proliferation and secretion of T and B lymphocytes and has anti-inflammatory effects through a reduction in the expression of pro-inflammatory cytokines and chemokines. Additionally, it inhibits platelet aggregation and shows suppressive properties against tumour cells [50]. The positive effects of polysaccharides as well as other phytochemicals present in mushrooms, are shown in [Table 3](#).

Table 3

Bioactive components in medicinal mushrooms and their health-promoting effects.

| Common Name | Latin Name                                     | Compounds with Bioactive Potential                                                                                                                                                                                     | Health-Promoting Effects                                                                                                                                                                                                       | References                                           |
|-------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| Reishi      | <i>Ganoderma lucidum</i> (Curtis) P. Karst.    | Polysaccharides<br>Glycoproteins (lectins)<br>Phenols<br>Steroids<br>Triterpenoids<br>Nucleotides<br>Fatty acids<br>Vitamins<br>Minerals                                                                               | Anti-inflammatory<br>Anticancer<br>Antiviral (including HIV)<br>Antimicrobial<br>Hypotensive effect<br>Cardiotonic<br>Immunomodelling<br>Nephrotonic<br>Hepatoprotective<br>Neurotonic<br>Anti-asthmatic                       | [21] <sup>a</sup> , [51], [52] <sup>a,b</sup> , [53] |
| Lion's Mane | <i>Hericium erinaceus</i> (Bull.) Pers.        | Hericerins,<br>Erinacins,<br>Glycoprotein,<br>Polysaccharides<br>Beta-glucans,<br>Sterols,<br>Lactone,<br>Fatty acids<br>Volatile compounds (e.g., hexadecanoic acid, linoleic acid, phenylacetaldehyde, benzaldehyde) | Anticancer,<br>Antioxidant,<br>Anti-ageing,<br>Immunomodelling,<br>Neurotonic,<br>Anti-asthmatic,<br>Hypoglycemic effects<br>Hypocholesterolemic effects                                                                       | [46] <sup>a,b</sup> , [53], [54] <sup>a,b</sup>      |
| Chaga       | <i>Inonotus obliquus</i> (Ach. ex Pers.) Pilát | Polysaccharides<br>Fatty acids<br>Hydroxy acids<br>Poliphenols (phenolic acids, flavonoids, coumarins, quinones, and styrylpyrones)<br>Triterpenoids (lanosterol)<br>Steroids (ergosterol and ergosterol peroxide)     | Antioxidant,<br>Anti-ageing,<br>Antimicrobial activity,<br>Antitumor activity,<br>Anti-inflammatory<br>hypoglycemic effect,<br>Antilipidemic effect,<br>Antigliccation effect,<br>Immunoregulatory<br>Cardioprotective effects | [14] <sup>b</sup> , [17,54,55]                       |
| Cordyceps   | <i>Ophiocordyceps sinensis</i> (Berk.)         | Cordycepin (purine alkaloid)                                                                                                                                                                                           | Antitumor,<br>Hypoglycemic effect                                                                                                                                                                                              | [49], [56] <sup>ab</sup>                             |

| Common Name                                                          | Latin Name                                                                         | Compounds with Bioactive Potential                                                                                                                                                                                                                         | Health-Promoting Effects                                                                                                                                                                                                   | References                                                |
|----------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
|                                                                      | G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora <i>prior name Cordyceps sinensis</i> | Cordymin (peptide)<br>Adenosine<br>Cordycepic acid (D-mannitol)<br>Trehalose<br>Polysaccharide<br>Beta-glucans<br>Saponins<br>Polyunsaturated fatty acids, Ergosterol<br>$\delta$ -tocopherol<br>Hydroxybenzoic acid                                       | Hypocholesterolemic effect,<br>Anti-inflammatory, Antioxidant, Antiaging activity, Antimicrobial activity,<br>Anticonvulsant activity,<br>Cardiovascular protection (reduces cardiac arrhythmia and chronic heart failure) | [57] <sup>a</sup> , [58] <sup>a</sup> , [59] <sup>a</sup> |
| Shiitake                                                             | <i>Lentinula edodes</i> (Berk.) Pegler                                             | Polysaccharides, Beta-glucans (lentinan)<br>Glycoproteins, Phenols, Steroids, Terpenoids, Nucleotides                                                                                                                                                      | Immune-enhancing effects,<br>Antitumor, Antioxidant, Antiaging activity,<br>Antimicrobial activity, Hypocholesterolemic effect,<br>Reduction in blood pressure                                                             | [26], [27] <sup>a</sup> , [60]                            |
| Turkey Tail<br>It also known as: Cloud mushroom, Yun Zhi, Kawaritake | <i>Trametes versicolor</i> (L.) Lloyd                                              | Polysaccharopeptide (PSP) and polysaccharide K (PSK)<br>(1,3)(1,6)- $\beta$ -D-glucans,<br>Poliphenols (phenolic acids: p-hydroxy benzoic, protocatechuic, vanillic, and homogentisic),<br>Vitamin B,<br>Fatty acids (linoleic, oleic, stearic, linolenic) | Antitumor<br>Immunoregulatory, Antioxidant activity<br>Prevent obesity, Antimicrobial, Antidiabetic<br>AChE inhibitorY                                                                                                     | [28,61], [62] <sup>b</sup>                                |

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<sup>a</sup>—in vivo studies. <sup>b</sup>—in vitro studies.

## 2.2. Proteins

In addition to polysaccharides, proteins, and peptides are important bioactive components that are present in mushrooms. Their content ranges widely from 4.6 to 56.3 g/100 g and is mainly determined by the mushroom species. Of the mushrooms discussed, Lion's Mane (*Hericium erinaceus* (Bull.) Pers.), Cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora), and Shiitake (*Lentinula edodes* (Berk.) Pegler) have the highest protein content (more than 20%) [23]. The amino acid composition and sequence and the length of the polypeptide chain can determine the specific biological activity of these compounds. They are most commonly ascribed to hypotensive, angiotensin-converting enzyme (ACE) inhibition, antioxidant, anticancer, antiviral, and antibacterial activities [63]. The most important bioactive fungal proteins include lectins (glycoproteins), immunomodulatory proteins, and proteins with enzymatic activity, e.g., nucleases, ribonucleases, laccase, and ergotionein [64]. Lectins increase insulin secretion and contribute to lowering blood sugar levels. In addition, they activate the immune system and show chemo-preventive effects against various types of cancer, e.g., hepatocellular carcinoma [65,66]. These compounds are present, e.g., in Reishi (*Ganoderma lucidum*). This type of protein, named TVC, was also isolated by Li et al. [67] from the fungus *Trametes versicolor*. As demonstrated by the authors, TVC increases the proliferation of human peripheral blood lymphocytes and is responsible for the increased necrosis of alpha tumour cells that are induced by mouse macrophages [67]. A characteristic low molecular weight peptide (cordymin) is present in cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora). Studies have demonstrated a protective role for this compound in lowering blood glucose levels in alloxan-induced hyperglycaemic rats. A dose of 50–100 mg/kg of the body weight of the animals also resulted in a reduction in aglycated haemoglobin (HbA11C) levels 5 weeks after the study. The oxidative stress induced by high sugar levels and the animal body weight decreased [68]. Numerous studies have shown that mushroom-derived protein has a complete amino acid profile. As highlighted by Thatoi and Singdevsachan [69], its nutritional value is



even greater than that of milk, meat, or egg proteins. The protein present in mushrooms can be characterised by a high content of essential amino acids and glutamic acid, aspartic acid, or arginine. Pop et al. [70] reported that the trametes versicolor contained as many as 18 types of amino acids like aspartic acid, threonine, serine, glutamic acid, glycine, alanine, valine, and leucine, which were identified. Furthermore, studies have confirmed the presence of ornithine, which is known for its particular physiological activity, and the non-protein neurotransmitter  $\gamma$ -aminobutyric acid (GABA) [71].

### 2.3. Lipids

The fat content in mushrooms varies depending on the species but can range from 0.1 to 5.9 g/100 g [19]. Among medicinal mushrooms, Cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones, and Spatafora) and Shiitake (*Lentinula edodes* (Berk.) Pegler) are the most abundant in fat. About 52–87% of the fat is made up of unsaturated fatty acids (UFAs) such as oleic (C18:1) and linoleic (C18:2) acids [1,25,71,72]. These acids predominate, for example, in Cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora). The minor fatty acid in this mushroom is saturated fatty acids, e.g., palmitic (C16:0) and stearic (C18:0) acids. Guo et al. [72] found that the fatty acid profile could vary depending on geographical origin in the example of cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora).

Comparative examinations between indoor-cultivated and wild *Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones, and Spatafora, conducted by Guo et al. [72], demonstrated that the wild mushrooms were characterized by a higher PUFAs (Polyunsaturated Fatty Acids) content with indoor-cultivated mushrooms. Such fatty acids as oleic acid, hydroxydocosanoic acid, hydroxytricosanoic acid, hydroxytetracosanoic acid, and hydroxypentacosanoic acid are predominate in Shiitake (*Lentinula edodes* (Berk.) Pegler) mushrooms. Stearic acid, hydroxyhexacosanoic acid, linoleic acid, palmitic acid,

hydroxyarachidic acid, hydroxyheneicosanoic acid, and hydroxy-tricosenoic acid are present in smaller amounts [17].

Linoleic acid is known to have anticancer effects on breast, colon, and prostate cancer; thus, as a natural source of this acid, medicinal mushrooms also exhibit such properties [73]. Furthermore, unsaturated fatty acids can be used for the production of tissue hormones and are useful in preventing excessive blood clotting.

## 2.4. Sterols

Mushrooms are also a source of sterols classified as bioactive compounds. The most common of these is ergosterol. This compound undergoes photolysis to vitamin D<sub>2</sub> when exposed to UV radiation [74]. A study conducted by Zheng et al. [75] showed that ergosterol exhibited cytotoxicity towards acute promyelocytic leukaemia cancer cells and liver cancer cells. At the same time, the authors noted moderate antimicrobial activity against selected bacteria and fungi. A characteristic sterol named H1-A, which resembles testosterone and dehydroepiandrosterone in its structure, was isolated from *Cordyceps*. In vivo studies in mice have shown that this compound could be effective for the treatment of selected autoimmune diseases [76].

## 2.5. Polyphenols

Thanks to the presence of polyphenols, including mainly phenolic acids represented by benzoic acid and cinnamic acid derivatives, medicinal mushrooms can be attributed to antioxidant activity. As reported by Ahmed et al. [77], gallic, caffeic, and p-coumaric acids are the predominant phenolic compounds in mushrooms. Phenolic compounds that are present in mushrooms exhibit strong antioxidant properties [78]. They inhibit free radicals and limit peroxide decomposition, scavenge reactive oxygen species, and block the action of metals when catalysing oxidation reactions [79,80,81]. Thus, they prevent mutations of cellular DNA and reduce the processes of carcinogenesis [82]. Peng and Shahidi [17] analysed Chaga ethanol extracts and detected 111

different phenolic compounds, including phenolic acids, flavonoids, coumarins, quinones, and styrylpyrones. Flavonoids in medicinal mushrooms are represented by myricetin, rutin, naringenin, quercetin, morin, and hesperetin [83]. Research conducted by Sharpe et al. [78] showed that, among many medicinal mushrooms, Chaga (*Inonotus obliquus* (Ach. Ex Pers.) Pilát) had the highest polyphenolic content and the highest antioxidant activity. The total phenolic content in this mushroom was at 97  $\mu\text{mol GAE/mg}$ , while the content in reishi (*Ganoderma lucidum* (Curtis) P. Karst.), shiitake, and turkey tail (*Trametes versicolor* (L.) Lloyd) was 21, 13, and 0.1  $\mu\text{mol GAE/mg}$ , respectively. The water-ethanol extract from Chaga (*Inonotus obliquus* (Ach. Ex Pers.) Pilát) exhibited approximately five times higher antioxidant activity against DPPH than other mushrooms. Mushroom polyphenols exhibit multidirectional beneficial effects on the human body: anticancer, antioxidant, hypoglycemic, slowing down the aging process, and preventing the degenerative diseases of the nervous system and cardiovascular diseases. When used as a food additive, they reduce fat oxidation processes and extend the shelf life of products [79].

## 2.6. Terpenes and Terpenoids

Another group of compounds includes terpenes, with the general formula  $(\text{C}_5\text{H}_8)_n$ , and terpenoids containing additional functional groups (-OH, -CHO, =CO, -COOH, -O-O-). Triterpenes are the main biologically active metabolites of terpenoid nature and are synthesized by *Ganoderma lucidum* (Curtis) P. Karst. and *Inonotus obliquus* (Ach. ex Pers.) Pilát. Data in the literature have reported that large amounts of these compounds, e.g., in reishi (*Ganoderma lucidum* (Curtis) P. Karst.) and chaga (*Inonotus obliquus* (Ach. ex Pers.) Pilát). Terpenes exert primarily anti-inflammatory effects. Triterpenes isolated from *Ganoderma lucidum* (Curtis) P. Karst. and *Inonotus obliquus* (Ach. ex Pers.) Pilát reduced the secretion of pro-inflammatory cytokines in macrophages (such as TNF- $\alpha$ , IL-1 $\beta$ , and IL-6) and the inflammatory mediators of nitric oxide (NO) and prostaglandin E2 (PGE2) [84,85]. Similarly, anti-inflammatory properties were exhibited by lanostane-type triterpene acids present in *Ganoderma lucidum* (Curtis) P. Karst.,

which, as shown by Akihisa et al. [85], inhibited the inflammatory process induced in mouse macrophages. In addition to anticholinesterase activity, the beneficial effects of mushroom terpenes have been reported in anticancer, antiviral, antimalarial, and antimalarial treatments [86,87]. The pharmacological effect of triterpenoids has been employed in the treatment of neurodegenerative diseases, including Alzheimer's disease [88].

## 2.7. Vitamins and Minerals

The nutritional value of medicinal mushrooms is also related to their high vitamin and micronutrient content. The vitamins present in mushrooms are mainly fat-soluble vitamins, including A and E, as well as vitamin D<sub>2</sub> (ergocalciferol) and provitamin D<sub>2</sub> (ergosterol). Interestingly, medicinal mushrooms are considered to be the only non-animal raw material that contains vitamin D [27,89]. Thanks to their tocopherol content, medicinal mushrooms exhibit antioxidant properties [89]. In addition, medicinal mushrooms are a very good source of water-soluble B vitamins (B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>6</sub>, B<sub>9</sub>, B<sub>12</sub>) and vitamin C [19]. The vitamin B<sub>12</sub> found in medicinal mushrooms was an analogue of that found in beef, fish, and liver, indicating its highly bioavailable. Therefore, mushrooms can be a valuable addition to vegetarian and vegan diets [90,91]. Shitake is rich in vitamins that exhibit antioxidant properties such as A, E, and C [27]. Medicinal mushrooms are rich in valuable mineral elements, including K, P, Na, Ca, and Mg, and, in smaller amounts, Cu, Zn, Fe, Mo, and Cd [27,79]. Given the ability of fungi to accumulate such heavy metals as Cd, Pb, Ar, Cu, Ni, Ag, Cr, and Hg, it is important that they grow in the least contaminated environment possible [92].

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## 3. Possibilities of Using Medicinal Mushrooms for Functional Food Production

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Medicinal mushrooms and mushroom-derived preparations containing bioactive compounds are classified as nutraceuticals. According to the

European Food Safety Agency, they can be used as supplements due to their health-promoting and disease-preventing activity [93]. The production of nutraceuticals requires a great deal of knowledge of the functional properties of individual mushroom species. Due to the possible presence of substances that are harmful to health, it is necessary to control the origin, cultivation conditions, and raw material processing in order to ensure the health and safety of nutraceutical products on the one hand and an adequate level of biologically active compounds on the other to guarantee the beneficial effects of its preparation on health [94]. Clinical studies have shown that the recommended dose of nutraceutical preparations varies depending on the diagnosis and the patient [95]. Currently, a variety of fungal preparations are commercially available, most commonly in the dry extract form. There is growing interest in exploring the possibility of using various medicinal mushroom preparations to develop functional foods. An example of a popular product with medicinal mushrooms such as Chaga (*Inonotus obliquus* (Ach. ex Pers.) Pilát), cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora), shiitake, lion's mane (*Hericium erinaceus* (Bull.) Pers.) or reishi (*Ganoderma lucidum* (Curtis) P. Karst.) is coffee. Its consumption regulates blood pressure, prevents heartburn, stimulates mental performance, boosts energy, and strengthens the immune system and performance of the organism [96]. Some medicinal mushrooms have also been used to enrich cereals, meat, fish, and beverage products (Table 4). Of the mushrooms discussed so far, reishi (*Ganoderma lucidum* (Curtis) P. Karst.) and shiitake (*Lentinula edodes* (Berk.) Pegler) have been used most commonly. In all food products, the addition of dried and powdered mushrooms resulted in an increase in protein and the total and insoluble dietary fibre and significantly increased the micronutrient content [66]. The introduction of mushroom powder at 5% in such bakery products as bread and biscuits did not have adverse effects of their quality [97]. In the case of additions above 5%, a deterioration in texture was often noted not only in bread but also in pasta, yoghurt, and cured meats (Table 4). There is no information in the literature on the possibility of using turkey tail (*Trametes versicolor* (L.) Lloyd), cordyceps (*Ophiocordyceps sinensis* (Berk.) G.H. Sung, J.M. Sung, Hywel-Jones and Spatafora), lion's

mane (*Hericium erinaceus* (Bull.) Pers.), or Chaga (*Inonotus obliquus* (Ach. ex Pers.) Pilát) preparations for food enrichment. Given the high health-promoting potential of these mushrooms, further research into the possibility of developing new functional foods with the above-mentioned mushrooms is advisable. The effect on the addition of selected medicinal mushrooms on quality parameters and the chemical composition of food products is presented in [Table 4](#). An important issue in the design and implementation of new food products is sensory quality. Scientific studies have shown that the addition of medicinal mushrooms to foods, especially in a crushed or powdered form, can have a negative effect on the taste, texture, flavour, colour, and appearance of products. The addition of alcoholic or aqueous mushroom extracts has a less negative impact on the sensory quality and, with a small amount (up to 4%), can even improve the selected sensory characteristics of products.

Table 4

Use of medicinal mushrooms for food enrichment.

| Common Name | Latin Name                                  | Product/<br>Size of Additive                  | Impact on Chemical Composition<br>(~) Lack of Impact<br>(↓) Decrease<br>(↑) Increase                                                   | Impact on Quality Parameters                                                                                                      | References           |
|-------------|---------------------------------------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Reishi      | <i>Ganoderma lucidum</i> (Curtis) P. Karst. | Smoked fish sausage<br>1% of crushed mushroom | (↑) Antioxidant properties<br>(↑) Total phenol content: +<br>(↓) Moisture: –<br>(↑) Ash: +<br>(↑) Protein: +<br>(↓) Fat: –<br>Fiber: + | (↑) Shelf life<br>(↓) Texture<br>Sensory evaluation: (↓) flavour, (↓) colour, (↓) taste, (↓) texture, (↓) appearance, (↓) overall | <a href="#">[98]</a> |
|             |                                             | 1% of water extract                           | (↑) Antioxidant properties                                                                                                             | (↑) Shelf life<br>(↑) Texture - Sensory                                                                                           |                      |



| Common Name | Latin Name                                  | Product/ Size of Additive                            | Impact on Chemical Composition<br>(~) Lack of Impact<br>(↓) Decrease<br>(↑) Increase                                        | Impact on Quality Parameters                                                                                                                     | References |
|-------------|---------------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------|
|             |                                             |                                                      | (↑) Total phenol content<br>(↓) Moisture: –<br>(↑) Ash<br>(↓) Protein: –<br>(~) Fat<br>(↑) Fiber: +                         | evaluation: (↑) flavour,<br>(↑) colour,<br>(↑) taste,<br>(↑) texture,<br>(~) appearance,<br>(↑) overall                                          |            |
|             |                                             | 0.25% of spore                                       | (↑) Antioxidant properties<br>(↑) Total phenol content<br>(↓) Moisture: –<br>(↑) Ash<br>(↑) Protein<br>(↑) Fat<br>(↓) Fiber | (↑) Shelf life<br>(~) Texture<br>Sensory evaluation: (↓) flavour,<br>(↓) colour,<br>(↓) taste,<br>(↓) texture,<br>(~) appearance,<br>(↓) overall |            |
| Reishi      | <i>Ganoderma lucidum</i> (Curtis) P. Karst. | Pilzner beer<br>0.1–1.5 mL/L of alcohol extract      |                                                                                                                             | Sensory evaluation:<br>(~) aroma<br>(↑) taste<br>(↑) body<br>(↑) bitterness<br>(↑) liveliness<br>(↑) overall impression                          | [99]       |
| Reishi      | <i>Ganoderma lucidum</i> (Curtis) P. Karst. | Emulsion Type Sausage<br>1% of dried fruiting bodies | (↑) Antioxidant properties                                                                                                  | Sensory evaluation:<br>(~) texture –<br>(↓) taste<br>(↓) Colour –<br>(↓) Smell<br>(↓) Acceptability                                              | [100]      |

| Common Name | Latin Name                                  | Product/ Size of Additive                                      | Impact on Chemical Composition<br>(~) Lack of Impact<br>(↓) Decrease<br>(↑) Increase                                                | Impact on Quality Parameters                                                                                      | References |
|-------------|---------------------------------------------|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------------|
|             |                                             |                                                                |                                                                                                                                     | (~) Peroxide value<br><br>(↑) Microbiological analysis +                                                          |            |
| Reishi      | <i>Ganoderma lucidum</i> (Curtis) P. Karst. | Bread 2/4/6/8% water extract                                   |                                                                                                                                     | (↑) Baking loss<br>(↓) Bitterness<br>Sensory evaluation: (↑) 2–4%,<br>(↓) 6–8%<br>Texture: (~) 2–4%<br>(↓) 6–8% – | [101]      |
| Reishi      | <i>Ganoderma lucidum</i> (Curtis) P. Karst. | Yoghurt 2% Industrial waste (residues from aqueous extraction) | (↑) anti-coli effect,<br>(↑) against <i>E. coli</i>                                                                                 | (↓) Texture<br>(↓) Taste                                                                                          | [102]      |
| Reishi      | <i>Ganoderma lucidum</i> (Curtis) P. Karst. | Semolina pasta enriched with 2.5 and 5% of mushroom powder     | (~) Phenolic compounds<br>(↑) ABTS antiradical properties<br>(↑) Syringic acid<br>(~) β-glucan content<br>(~) Anticancer properties | Not analyzed                                                                                                      | [103]      |
| Lion's Mane | <i>Hericium erinaceus</i> (Bull.) Pers.     | Semolina pasta enriched with 2.5 and 5%                        | (~) Phenolic compounds<br>(~) Antioxidant properties                                                                                | Not analyzed                                                                                                      | [103]      |

| Common Name | Latin Name                             | Product/<br>Size of Additive                          | Impact on Chemical Composition<br>(~) Lack of Impact<br>(↓) Decrease<br>(↑) Increase                | Impact on Quality Parameters                                                                                                                                                                                                                                                                        | References |
|-------------|----------------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
|             |                                        | of mushroom powder                                    | (~) ABTS antiradical properties<br>(↑) Vanilin<br>(~) β-glucan content<br>(~) Anticancer properties |                                                                                                                                                                                                                                                                                                     |            |
| Shiitake    | <i>Lentinula edodes</i> (Berk.) Pegler | Biscuits with mushroom powder 10%                     | (↑) Protein<br>(↑) Mineral (Fe, P, Zn, Ca)<br>(↑) Total and insoluble dietary fibre                 | Sensory evaluation: (~) aroma,<br>(~) colour,<br>(~) texture,<br>(~) shelf life                                                                                                                                                                                                                     | [104]      |
| Shiitake    | <i>Lentinula edodes</i> (Berk.) Pegler | Bread enriched with 5–15% addition of mushroom powder | (↑) Dietary fiber                                                                                   | Bread dough:<br>(↑) water absorption;<br>(↓) development time;<br>(↓) stability;<br>>5% decreased the dough strength<br><br>Bread quality physical:<br>(↓) loaf height;<br>(↑) moisture content;<br>(↓) specific volume;<br>>5% (↑) bread's gumminess;<br>>5% bread's (↑) hardness;<br>(↓) porosity | [97]       |

| Common Name | Latin Name | Product/ Size of Additive                                      | Impact on Chemical Composition<br>(~) Lack of Impact<br>(↓) Decrease<br>(↑) Increase | Impact on Quality Parameters                                                                                | References |
|-------------|------------|----------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|------------|
|             |            | Pork patties                                                   |                                                                                      |                                                                                                             |            |
|             |            | 0–6% addition to mushroom powder                               | Not analyzed                                                                         | (↑) texture +;<br>(↑) juiciness +;<br>(↑) moisture +                                                        | [105]      |
|             |            | Semolina pasta enriched with 5–15% addition of mushroom powder | Not analyzed                                                                         | (↑) Cooking loss<br>(~) Water absorption;<br>(~) Moisture content;<br>(~) Tensile strength;<br>(↑) Firmness | [106]      |

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#### 4. Conclusions or Concluding Remarks

To date, a great deal of research has already been conducted into medicinal mushrooms; however, given the diversity of species and the amount of bioactive substances contained therein, this area still appears to be incompletely explored. It seems advisable to conduct research not only to isolate and identify the bioactive substances present in mushrooms but also to conduct clinical experiments to confirm the therapeutic effect of these substances. Such studies could facilitate a determination of the dose and duration of use for mushroom nutraceuticals. Toxicological studies confirming the safety of medicinal mushrooms are also needed. In the context of using medicinal mushrooms for the development of functional foods, it is important to study the interactions between the biologically active compounds present in mushrooms and food ingredients. It is important to bear in

mind that the components present in the food matrix may act synergistically or antagonistically with mycochemicals, increasing or reducing their beneficial physiological effects, respectively. Based on the analysis of available information and scientific research, it can be concluded that the addition of medicinal mushrooms to foods, especially cereal products, can make their chemical composition more attractive due to their great health-promoting properties and the presence of biologically active compounds. Medicinal mushrooms are known for their potential to improve immunity, regulate metabolism, and prevent many diseases. The abundance of polysaccharides, polyphenols, amino acids, and vitamins in medicinal mushrooms is a valuable source of biologically active compounds that can contribute to maintaining the health and well-being of the body. At the same time, further scientific research is needed to confirm these benefits and develop optimal methods for the addition of medicinal mushrooms to foods, taking into account technological, sensory, and food safety aspects.

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## Conflicts of Interest

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The authors declare no conflict of interest.

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## Footnotes

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# Mushrooms For Brain Health



Mushrooms have been used in cuisine throughout the world for ages, and the health benefits of incorporating them into an individual's diet are well-known. They have long been considered a powerful medicine in many parts of the world; however, western medicine is fairly new to this concept.

The research is hard to ignore, and numerous studies have been conducted that demonstrate the value of mushrooms not only for general health but, particularly, for brain health. There are more than a thousand species of edible mushrooms, so knowing which ones to use to promote a healthy brain can be difficult. Read on to learn which particular mushrooms provide the best source to support brain health.

## What Are The Overall Health Benefits of Mushrooms?

Although different mushrooms deliver different benefits, in general, edible mushrooms are excellent sources of antioxidants, fiber, and vitamins. Antioxidants are substances that fight free radicals in the body. These free radicals are responsible for damaging the tissue in our body leading to major chronic health problems like cardiovascular disease.

Fiber is essential to maintain a healthy digestive system. It is lacking in so many Americans' diets, and can help to maintain a healthy weight, ease bowel movements, and lower cholesterol.

Mushrooms can provide a variety of necessary vitamins. Generally, the nutrients found in mushrooms contain B vitamins, [Vitamin D](#), selenium, and potassium. These vitamins and minerals are responsible for fostering a strong immune system, building protein, and reducing inflammation.

## How Do Mushrooms Support A Healthy Brain?

As we age, our cognitive function declines, and we become more predisposed to illnesses like Alzheimer's disease and [dementia](#). Mushrooms have been shown in studies to reduce the risk of mild cognitive impairment (MCI), which is often a precursor to Alzheimer's disease. MCI is characterized by poor memory, difficulty making decisions, and verbalizing thoughts.

In addition to the anti-inflammatory effects of mushrooms which can certainly aid in brain function, they contain a specific [amino acid](#), ergothioneine which is not produced in the body naturally. Ergothioneine is a strong antioxidant, and there is increasing evidence that this substance can prevent diseases associated with aging. In fact, one study showed that patients with dementia and decreased cognitive impairment had low blood levels of ergothioneine. [\[1\]](#)

One particular large study conducted in Singapore directly examined the correlation between mushroom intake and MCI. The results showed that individuals who consumed two portions of mushrooms per week or more had a reduced risk for mild cognitive decline. [\[2\]](#)

## Types Of Mushrooms For Brain Health



With all the varieties of mushrooms available, it may seem impossible to know which ones are the best to support brain function. The most effective mushroom for this is Lion's Mane. It has been extensively studied for its neuroprotective properties. Reishi and Chaga are also excellent sources to improve cognitive function.

## Lion's Mane

Many substances are unable to cross a barrier to our brains, rendering them ineffective to aid in brain function. Lion's Mane has gained notoriety as one of the best mushrooms for brain health because it has the ability to cross the [blood-brain barrier](#). In one report published in the National Institutes of Health database, Lion's Mane was shown to repair damaged nerve cells. [3] This report looked at a study that revealed improving cognitive impairment in older Japanese patients after oral administration of Lion's Mane. [3]



## Reishi

The reishi mushroom is well-known for its mood-boosting effects. It helps alleviate symptoms of anxiety and depression and promotes better sleep. Improved sleep



helps our brains function at optimal capacity. It has also been shown to sharpen focus.



## **Chaga**

Chaga mushrooms are best at lowering cholesterol in the body. They are also powerful antioxidants, strong in protecting against inflammation, which is associated with poor cognitive function. The Chaga mushroom is now being studied further as a preventative agent to slow the growth of cancer cells.

## **Side Effects Of Mushrooms**

The side effect profile is very safe for mushrooms. Those that have been studied have shown no adverse effects when taking them; however, mushrooms, in general, may trigger an allergic reaction. Individuals who have food allergies or sensitivities should be tested for a mushroom allergy before using mushrooms for their health benefits.

# Our Top 3 Picks Of Mushroom Supplements For Brain Health

Because it is the most studied and has been proven to improve mental cognition, our top three choices for mushroom supplementation all contain Lion's Mane.

**Stonehenge Health Dynamic Mushrooms** – This supplement contains Lion's Mane, Reishi, and Chaga mushrooms. The vegetarian capsules are non-GMO and are gluten, soy, and dairy-free. Also, this supplement utilizes the cap and stem of the mushrooms, which includes the highest amount of nutrients mushrooms offer.

**Real Mushrooms Lion's Mane** – This organic formulation also uses the cap and stem of the mushroom. The manufacturer asserts that the quality of their product is verified by accredited third parties and practitioners are recommending this product to their patients.

**Naturelo Mushroom Supplement** – This formulation has both Lion's Mane and Reishi. The capsules are vegan-friendly, and the price is reasonable.

**[Genius Mushrooms](#)** – This formulation contains a blend of organic Lion's Mane, Reishi, and Cordyceps. It is designed to improve focus, energy, and immunity.

## Our Recommendation

It seems obvious that incorporating mushrooms into your life either through diet or supplementation is a smart decision. The health benefits are plentiful, and the improved cognition is well-established. Our only concern is the allergy component, so if you are unsure, you can easily be tested to confirm you can ingest mushrooms. As always, speak to your doctor before beginning any new supplements.



Everything you need to know about what foods to eat (and which to limit) for a sharp and agile mind.© Hearst Owned

Think of eating [healthy foods](#) as plugging in the fastest, most efficient charger to power up the battery of your brain. Or as high-octane fuel that keeps the engine of your brain humming efficiently along. Whichever metaphor you choose, [science](#) makes it clear that the foods you eat can fuel and charge your brain and help keep it sharp and clear, both now and long-term.

## Why the gut is key

So how exactly does the food you eat fuel a healthy brain? It does this largely via the [microbiome](#) and the gut-brain connection, says [Uma Naidoo, M.D.](#), a Harvard-trained nutritional psychiatrist, professional chef, and nutritional biologist. She's the author of the bestselling [This Is Your Brain on Food](#) and the new book [Calm Your Mind With Food](#).

The [gut microbiome](#) is an ecosystem of microorganisms that's critical to our health in a number of ways. And the conversation between it and the brain is constant, says Dr. Naidoo. "Information from the foods we eat is communicated to our brain and impacts our overall mental health," she says. "When

there's [inflammation](#) in the gut, we also see inflammation in the brain, which is linked to a host of mood and cognitive disorders. Also, more than 90% of the receptors for the neurotransmitter serotonin—which is responsible for mood and cognition—are located in the gut. This highlights just how powerful this food-mood connection is!"

Foods that are [heart-healthy](#) also tend to be good for the brain, Dr. Naidoo adds. "We're learning now, more than ever, that the body works as one large system, rather than several independent organ systems, and that the microbiome plays a significant role in supporting the health of all our organs. Through this, we see that many foods that optimize the microbiome also support both cardiovascular and brain health."

## Feeding your brain the right way

When it comes to fueling your brain, the [best foods](#), says Dr. Naidoo, "are minimally processed ones that are in their most natural or whole state. Foods like vegetables, berries, organic meats—even grass-fed red meat in moderation—whole grains, legumes, nuts, and seeds are all nutrient-dense foods. They provide the body and mind with a diversity of vitamins, minerals, antioxidants, fiber, and other important food components that support optimal wellbeing."

Think about this while you're food-shopping, suggests Dr. Naidoo. "Shop the perimeter of the grocery store," she says. That's where you tend to find produce, healthy sources of [protein](#) in the meat and seafood areas, dairy, and frozen food. Then move on to the rest of the store. "The center aisles are great for canned chickpeas, black beans, and cannellini beans, dried beans and lentils, and canned salmon, oysters, and mussels," she adds. You can also find whole grains like farro and quinoa.

Don't forget the spice aisle, Dr. Naidoo says, including turmeric, black pepper, saffron, rosemary, and parsley. And be sure to include fermented foods like plain yogurt, kimchi, and sauerkraut, she adds. These foods are [known](#) to improve gut health, and there is some [research](#) that they are associated with a lower risk of dementia.

## Foods to limit or skip

One key thing to consider, when it comes to your brain health, is the amount of added or refined sugars you're consuming. [Studies](#) on rats have found a link between sugar intake and cognitive function, such as memory and decision-making. Other rodent [research](#) showed that a diet high in sugar increased inflammation in areas of the brain involved in memory.

Dr. Naidoo recommends that people avoid added or refined sugars for optimal mental fitness, as well as the foods below:

- Processed packaged foods or baked goods
- Refined seed oils
- Processed meats

## Two diets worth following

There are two eating plans, the [Mediterranean diet](#) and the [MIND diet](#), that are worth knowing about. They aren't diets in the way we often think about that word: They're not about calories or weight loss. What they are: powerful tools for the health of your brain.

The Mediterranean diet, [research](#) has shown, helps reduce the risk of a whole host of diseases, including heart and neurodegenerative diseases. In fact, the [World Health Organization](#) calls it the dietary approach that's been studied most extensively for cognitive health. The recommended foods are colorful fruits and vegetables, nuts and seeds, olive oil, seafood, legumes and beans, whole grains, and fresh herbs. Other foods are suggested in moderation: dairy, eggs, and poultry.

The MIND diet is also supported by research, including a [study](#) of 900 people that showed a 53% reduced risk of Alzheimer's and dementia among those who followed it closely and limited refined sugar, red meat, and fried foods. According to [Harvard](#) research, it focuses on foods that are packed with vitamins, flavonoids,

and other substances that reduce inflammation and [oxidative stress](#) (an imbalance of free radicals and antioxidants in the body). It's very similar to the Mediterranean diet, with a special emphasis on foods that have been specifically shown to have cognitive benefits, like the options below.

## **Powerhouse foods with health benefits**

Here's why these choices are especially smart picks for your brain:

### **1. Dark, leafy greens**

All vegetables are good for your noggin, so it's smart to include a variety. [Dark leafy greens](#), such as spinach and kale, are particularly known to be brain-smart.

### **2. Berries**

Various types of fruit are healthy choices for your mind; [studies](#) have shown that berries are especially packed with cognitive benefits.

### **3. Nuts**

Polyphenols are plant compounds found in many varieties of nuts; [research](#) indicates that they could be preventative against dementia. Walnuts are an especially smart pick due to their concentration of cognitive-boosting omega-3s.

### **4. Beans**



Beans are rich in nutrients that power the brain, including folate, magnesium, and zinc, says the [United Brain Association](#). They're also high in fiber, which helps balance blood sugar (good for the heart and brain) and assists in keeping bad cholesterol in check.

## 5. Whole grains

Sticking to whole grains as opposed to refined ones helps you avoid [metabolic syndrome](#), which leads to problems with both the heart and brain. And [studies](#) have shown that people who eat the most whole grains had fewer reported mood disorders, such as depression and anxiety. More research is needed to figure out the connection, but it's safe to say that when it comes to grains, it's better for your brain to focus on whole rather than refined.

## 6. Salmon

There's a lot of research about the brain benefits of eating seafood, including a [recent study](#) that showed an association between eating fish twice a week and a lowered risk of vascular brain disease. Salmon is a good option because of its high levels of brain-boosting [omega-3 fatty acids](#).

## 7. Olive oil

This staple of the Mediterranean and MIND diets seems to be highly beneficial to that gut-brain axis; for instance, a 2021 study in [Nutrition Reviews](#) found that it shows great potential for modifying the gut microbiota in a healthy way. It's full of natural antioxidants, is protective against oxidative damage, and was shown in a [mice study](#) to improve activity between the brain's synapses.

Consider fitting all of these into your day! You could start with breakfast quinoa topped with berries; a lunch of white bean soup plus a salad of baby kale sprinkled with chopped walnuts and strawberries, tossed in an olive oil

vinaigrette; and a dinner of salmon over spinach sauteed in olive oil. Add other fruits and veggies, a snack of yogurt, lots of fresh herbs and spices, and you have a delicious day of brain-boosting goodness.

[More from Your Brain: An Owner's Manual](#)



Your kidneys are important for your overall well-being, so don't forget to take care of them.

**Y**our [kidneys](#) are some of the most important organs in your body. Not only do they [remove waste](#) and excess fluid from your blood, but they maintain the levels of potassium, sodium and other essential minerals that your body needs to survive. The kidneys also create hormones that regulate important health factors like [blood pressure](#) and [bone strength](#). But despite all that, they still remain underappreciated compared to organs like the [heart](#) or [lungs](#).

The kidneys do a lot, so they can become overworked without your notice. Roughly [one in seven American adults](#) has [chronic kidney disease](#), which can cause waste and fluid buildup in your body.

Your [risk for CKD](#) is partly tied to the foods you eat. Eating the wrong things can increase your risk, while filling your diet with nutrient-rich foods can safeguard

your kidney health. Follow this list of the top 13 kidney-friendly foods you should eat more of.

## 13 best foods for healthy kidneys

These are our top picks for foods to add to your diet for optimal kidney health.

### 1. Fatty fish

Fish delivers protein, and when you choose a fatty fish like tuna, salmon or trout, you're also getting omega-3 fatty acids. [Omega-3 fats](#) may help reduce fat levels (triglycerides) in the blood and may also lower blood pressure, according to the [National Kidney Foundation](#).

If you have CKD, you may need to keep an eye on the phosphorus and potassium levels of the fish you choose. The National Kidney Foundation has [a chart you can use](#) to determine levels in specific types of fish. Although, it's best to consult with your doctor.

### 2. Cabbage

This [nutrient-dense vegetable](#) is low in both potassium and sodium while packing in fiber, vitamins C and K and more.

Plus, cabbage is versatile. You can use it in salads and slaws, but you can also use it as a wrap for tacos, sandwiches and more.

### 3. Bell peppers

Like cabbage, [bell peppers](#) pack in lots of good nutrients with low levels of potassium. With them, you get vitamins B6, B9, C and K, plus fiber. And they deliver antioxidants, too.

You can slice them and eat them with dips or roast them and add them to dinner.

**Read more:** [8 Things Your Body Is Telling You About Your Vitamin Intake](#)

## 4. Cranberries

Cranberries [help to prevent](#) urinary tract infections. While these usually stay in your bladder, they can travel up to your kidney, making kidney problems worse. Fortunately, regularly consuming cranberries can help you avoid this unwelcome situation.

Plus, [cranberries](#) have antioxidants that can help to fight inflammation, and they can boost your heart and digestive health. It turns out, these tart berries aren't just for the Thanksgiving table.

## 5. Blueberries

We've talked about some of the best foods for kidneys, but you can take it a step further. The question is: What [foods help repair kidneys](#)? [Blueberries](#) deliver here.

With high levels of antioxidants and loads of [vitamin C](#) and fiber, blueberries are all-around healthy. They can also help to reduce inflammation and support bone health, reversing some of the issues that can come with CKD.

## 6. Dark, leafy greens

There are plenty of reasons to turn to [dark, leafy greens](#) like spinach or kale. They deliver so many nutrients that they can help you get key vitamins and minerals, plus immunity-boosting benefits.

Be advised, though, that greens can come with a decent amount of potassium. If you have CKD, talk to your doctor before adding more of these to your diet.

## 7. Olive oil

Rich in antioxidants and healthy fatty acids, olive oil can boost your overall wellness. [A study from Harvard University](#) found that olive oil may lower cholesterol levels and the risk of cardiovascular disease, dementia and some types of cancer.

Beyond all this, it can help you add flavor to dishes without turning to salt or butter.

To get more antioxidants, choose unrefined or cold-pressed olive oil that's virgin or extra virgin.

## 8. Garlic

Another antioxidant-rich, inflammation-fighting food, garlic also contains a specific compound called allicin. For [people with CKD](#), allicin -- an active compound found in garlic -- worked just as effectively to help protect kidney health as a prescription drug. If you're looking for the best foods for your kidneys, garlic has to make the list.

Plus, it's an excellent way to add flavor when you're skimping on salt.

## 9. Onions

From the same family as garlic, [onions](#) give you another excellent and salt-free way to add flavor (bonus points if you saute them in olive oil). Onions also deliver important nutrients like vitamins B6 and C, manganese and copper.

They also contain quercetin, a chemical that can help your body fight cancer, and organic sulfur compounds that can reduce your risk of high blood pressure, stroke and heart disease.

## 10. Cauliflower

[Cauliflower](#) brings the crunch, paired with plenty of vitamins C, B6, B9 and K, along with fiber. It also contains compounds your body can use to neutralize certain toxins -- a big help when your kidneys aren't doing their best filtration work.

Cauliflower does contain some potassium and phosphorus, though, so while it makes the list of foods good for kidneys, people with CKD may want to moderate their intake.

## 11. Egg whites

[Egg whites](#) are specifically recommended for people with kidney problems. They give you a way to increase your protein levels -- which can be important with later-stage CKD, especially if you're on dialysis.

## 12. Arugula

[Arugula](#) is packed with nutrients your body needs like magnesium, iron, calcium and vitamins A, B9, C and K. Plus, it's antioxidant-rich and has glucosinolates, which can help your body protect itself against a range of cancer types.



You can eat arugula raw (it's a great salad base), but you can also sprinkle it over whatever you're whipping up. It's great on pizzas, in omelets and with pasta, for example.

## 13. Apples

Apples deliver the cancer-fighting quercetin and fiber that can help to keep your cholesterol and blood sugar at healthy levels. And they've got plenty of antioxidants



The study tracked 400,000 people from 1995 through 2019.

A new study shows that a plant-based diet is even healthier than previously believed and could likely extend your lifespan.

According to a report posted by [Medical Xpress](#), a new study from the National Institutes of Health shows that getting the majority of the fats in your diet from plants, such as nuts, grains, or [vegetables](#), rather than animal products like meat, cheese, and butter saw significantly reduced risks of dying during the 24-year study period and a sizable decrease in the chances of death from heart disease.

The study tracked over 400,000 people from 1995 through 2019, sorting them into five groups depending on how much plant or animal fat they ate as part of their diet.

According to Dr. Demetrius Albanes, who led the study, it "provides evidence that diets high in animal-based fats, including dairy and eggs, are associated with elevated risks of overall and cardiovascular disease mortality."

According to the study, those who were in the top 20% — or those whose diets consisted of the most plant-based fatty acids — had a 9% lower chance of dying from any cause and a 14% lower chance of dying from heart disease than those who were in the lowest 20%.

Taking the data further, those who got the majority of their fats from vegetable oils compared to other sources had "12 percent lower odds for all-cause death and 15 percent lower odds for death from heart disease."

To further drive home the point, the study showed that those who ranked in the 20% whose diets included the most animal-based fats had a 16% higher chance of dying from heart disease and a 14% higher chance of dying from any cause.

Other studies have shown that plant-based diets [reduce stress](#) and anxiety as well as reduce the severity of [prostate cancer](#).

Apart from the obvious health benefits of a [plant-based diet](#), moving away from an animal-based farming system will have a significant benefit to our planet as well. According to an [EPA report](#) from April, summarized by the Center for Biological Diversity, agriculture is the leading source of the United States' [methane](#) and nitrous oxide pollution — two of the primary planet-warming gases — and animal agriculture is responsible for 36% of the [methane](#).

If we reduce our dependence on animals in our diet, we can reduce the amount of dangerous gases they produce, which helps cool our planet.

Dr. Albanes' study also noted that switching to a plant-based diet could still make a significant impact on your well-being.

"Replacement of 5% energy [intake] from animal fat with 5% energy from plant fat, particularly fat from grains or vegetable oils, was associated with a lower risk for mortality," the study said, per Medical Xpress, pointing out a "4% to 24%

reduction in overall mortality, and 5% to 30% reduction in cardiovascular mortality."

## 4 supplements a doctor specializing in nutrition and healthy aging takes daily, including herbs and vitamins

Story by kschewitz@businessinsider.com (Kim Schewitz)

- Dr. Michael Greger has dedicated his career to studying how lifestyle choices can help us live longer.
- As well as eating a whole-food plant-based diet, he takes supplements daily.
- These include vitamin B12, which he recommends anyone following a plant-based diet take.

Dr. Michael Greger has dedicated his career to studying aging and helping his patients and the general public lead healthier lives.

A physician who specializes in nutrition and an author, Greger shares information about how [lifestyle choices](#) can impact lifespan and makes recommendations based on research from his books, including "How Not To Die" and "How Not To Age," and via his charity, NutritionFacts.org.

**Tech execs like Bryan Johnson and Sam Altman are optimizing their diets to live longer. Here's what experts say to eat to expand your lifespan, from blueberries to red onions.**©Pixabay

- As a quest for longevity sweeps the nation, people are [taking supplements and prescription pills to reverse aging](#).
- Research shows that diet also plays a role in determining — and even increasing — a person's lifespan.
- Here's a list of fruits, vegetables, and drinks that experts say can lead to a longer life.

Some billionaires, like Elon Musk, [opt for a donut for breakfast](#). Others, like biotech entrepreneur Bryan Johnson, [methodically prepare smoothies](#) with compounds like creatine, spermidine, and collagen peptides, and [consume copious amounts of vegetables](#). Tech billionaires clearly don't have identical diets, or even the same goals for their health. Still, those like Johnson aren't [abiding by fastidious nutrition plans](#) simply to stay healthy — they're aiming to live longer.

## Mind your protein intake

Although there's certainly an overlap between eating for general health and eating to live longer, longevity experts say there are also a few key differences. Dr. Anant Vinjamoori, chief medical officer of longevity-focused healthcare company [Modern Age](#), suggests looking at protein intake as an example.

"Protein is essential for building and maintaining muscle mass, and having adequate muscle mass is important for healthy aging." At the same time, Vinjamoori said, "protein intake is also known to work against some of the beneficial, restorative pathways in our body."

That idea is corroborated by the work of [Dan Buettner, who founded the longevity brand Blue Zones](#). Buettner spent years studying the habits of those in what are called "Blue Zones," regions of the world where [people tend to live to the age of 100](#).

Across all five [Blue Zones](#) — Loma Linda, California; Nicoya, Costa Rica; Sardinia, Italy; Ikaria, Greece; Okinawa, Japan — Buettner and his team found that people consume less protein (especially animal protein) than the rest of the world.

## Go vegetarian or vegan

David Sinclair, a Harvard Medical School professor and longevity researcher, takes the argument against animal protein one step further, contending that the best way to live longer is by dropping meat entirely. In an interview with The Knowledge Project Podcast, Sinclair [said](#) that high animal protein diets may help people look and feel great, but only in the short term.

"I'm convinced, and the data shows it from population studies, that a carnivorous diet is not a longevity producing diet in the long run," he said.

Several powerful figures in the tech industry don't eat meat either. [OpenAI's Sam Altman](#) is vegetarian while [Twitter cofounder Biz Stone](#) is vegan.

## Breaking it down to the cellular level

Vinjamoori said that it can also be helpful to think about eating for longevity from the cellular level. "I start with the question of what cellular processes I want to optimize, determine which compounds have been shown in research to optimize those processes, and then to find foods that have high concentrations of those compounds," he said.

Business Insider set out to figure exactly which foods would optimize those processes, and ultimately, help you live longer. Read more, below.

See more

Greger endorses a whole-food, [plant-based diet](#) similar to the one eaten in [Blue Zones](#), which are areas including Sardinia, Italy, and Loma Linda, California where people live around a decade longer than the country's average.

However, he also takes some [supplements](#) that he believes are [beneficial for longevity](#).

In the US, supplements aren't FDA-regulated in the same way as over-the-counter medications, he told Business Insider. So it's hard to guarantee that a supplement contains what its label says, he said.

"They're just really not concerned about purity because there's really no incentives. They just want to make something dirt cheap so they can sell it. So I'm concerned about contaminants," Greger said of some supplement manufacturers.

So he makes sure he's taking a high-quality product by only using supplements tested and [verified by USP](#), a non-profit focused on drug quality and safety.

He shared four supplements that he takes regularly to help boost his health and prevent disease.

## Vitamin D

Greger takes a [vitamin D supplement every day](#). It helps the body absorb calcium and phosphorous and is needed for healthy teeth, bones, and muscles.

There is also some research to suggest that vitamin D might be protective against advanced cancer, but overall, data suggests that there isn't a link between vitamin D and developing cancer, according to the American Cancer Society.

Most people get enough vitamin D from sunlight, but those living in colder climates are unlikely to get enough during winter and fall.

[Vitamin D is found](#) in a small number of foods including animal products such as oily fish, red meat, egg yolks, and some fortified products such as breakfast cereals.

Greger eats mainly plant-based foods and said that he doesn't get enough sun, particularly in the winter, so he takes 2,000 International Units of vitamin D3, which is usually found in animal products.

That is higher than the daily 600 IU of vitamin D recommended by the National Institutes of Health, but Greger believes this is the amount required for optimal health.

The maximum suggested daily requirement is 4,000 IU per day for healthy adults, according to The Cleveland Clinic.

## Vitamin B12

[Vitamin B12](#) supports the function of nerve cells and is needed for red blood cell formation and DNA synthesis.

Like vitamin D, it's almost exclusively found in animal products and you can't get it from the sun, meaning vegetarians and vegans are at risk for deficiency.

"People eating a plant-based diet must ensure a regular, reliable source of vitamin B12 throughout their lifespan," Greger said.

Greger said he takes 2,000 micrograms of vitamin B12 a week. The recommended daily allowance is 2.4 mcg daily, however, the lowest doses in B12 supplements tend to be many times the recommended dietary allowance, according to Harvard Medical School. This is because the body doesn't absorb most of what's in the supplement.

Vitamin B12 is generally considered safe, even at high doses, and has no established maximum dose, according to Healthline.

## Algae-based DHA

Greger takes an algae-based DHA supplement daily for brain health and cognitive function, he said. DHA is an omega-3 fatty acid, and it makes up 25% of the brain's total fat content. The brain is 60% fat in total.

DHA is crucial for brain development in infants, but it might also help prevent cognitive decline and memory problems as we age, according to a [2016 review](#).

With age, the brain goes through natural changes, such as a reduced ability to absorb nutrients, and DNA damage, which mimics what happens when DHA levels fall, according to Healthline.

There is some [evidence](#) that taking a DHA supplement can improve memory and other brain functions in people with mild memory problems.

## Turmeric, black cumin, ground ginger, and amla

Every day, Greger makes a supplement himself by wrapping up ground turmeric, black cumin, ground ginger, and dried gooseberry powder, also known as amla, in edible film, which is essentially a transparent sheet of potato.

"These are whole foods. They're not really supplements," he said. "You put the powders that taste horrible, and you wrap it up like a wonton, dip it in water, and then you just swallow this little pouch."

They all contain [antioxidants](#), molecules that fight free radicals in the body. These are compounds that can cause illnesses such as heart disease, cancer, and diabetes.

[Turmeric](#) contains polyphenols, which are anti-inflammatory, while research suggests that black cumin could also lower cholesterol levels. Ginger can help with digestion and bloating.

Amla is a [great source of vitamin C](#), which is good for immune function, and has been linked to improved cholesterol levels.





The headquarters of Beyond Meat in El Segundo. ((Christina House/Los Angeles Times))© (Christina House/Los Angeles Times)

**M**cDonald's is putting Beyond Meat's plant-based chicken McNuggets on its French menu, marking an expansion of the El Segundo company's European business.

The [Veggie McPlant Nuggets](#), made from wheat and pea proteins, will be served at all of McDonald's 1,560 restaurants in France on a permanent basis, the fast food company said this week.

"With a constant increase in the number of French people adopting a vegetarian or flexitarian diet, McDonald's is responding to changing eating habits," McDonald's said in a press release.

Last year, the chain launched both its McPlant Nuggets and McPlant Burger, also supplied by [Beyond Meat](#), in Germany, where they are now permanent menu items. The McPlant Burger is also on the menu to stay in the U.K., Netherlands, Austria, Baltics, Malta and Slovenia, Beyond Meat said.

"We are ... proud to help bring more choice to the McDonald's menu for consumers looking to diversify their proteins with plant-based options," a company spokesperson said in a statement.

A bellwether stock in the plant-based meat industry, Beyond Meat [has been struggling](#) as the novelty of the products has worn off and questions have risen about their healthfulness — something the company blames on a lobbying campaign led by the meat industry.

Beyond Meat's sales have fallen since 2021 as their losses have grown. That has depleted its cash reserves, which along with short-term investments totaled \$145 million at the end of the second quarter — after topping \$1 billion in 2021, according to FactSet. Its stock is down more than 90% over that period, with shares trading around \$6.50 Thursday on the Nasdaq.

John Baumgartner, an analyst at Mizuho Securities, said the announcement adds to progress Beyond Meat has already made in Europe — but the larger issue is its struggles making headway in the domestic fast-food industry.

"They haven't been able to make it work in the U.S.," he said, noting Beyond's plant-based products have been discontinued at Dunkin' Donuts and other North American chains.

McDonald's tested the [McPlant Burger at stores in the San Francisco and Dallas areas but they did not perform well](#) and the company did not pursue a nationwide rollout, a McDonald's executive said this year. However, McDonald's plans to focus on plant-based chicken products where there is more demand, he added.

Last week, Beyond Meat announced that [Panda Express was expanding](#) the number of outlets serving a plant-based version of the company's orange chicken to 600 stores across the country.

Beyond Meat this spring also rolled out a [new version of its burger](#), with a lower fat content that garnered endorsements from leading health and nutrition groups — a key strategy in turning around its business. It will release third quarter earnings next month that will provide insight into how well the burger is selling.

It also has released a new product line called [Beyond Sun Sausage](#) that unlike the company's core products does not seek to mimic and replace meat. The sausages are made of fruits, legumes and vegetables and are certified by the American Heart Assn. and the American Diabetes Assn.

Baumgartner said the new sausages appears to be a "hedge product" that appeals to traditional vegetarian and vegan consumers. He called the company's turnaround efforts a "work in progress" that has improved the product line but has yet to show results.

"You're still not seeing it in sales, and their cash position doesn't give them a lot of wiggle room," he said.

This story originally appeared in [Los Angeles Times](#).

*Sign up for CNN's Eat, But Better: Mediterranean Style. [Our eight-part guide shows you a delicious expert-backed eating lifestyle that will boost your health for life.](#)*

Worried about your type 2 diabetes risk? You might want to look at the kinds of meat you are eating, according to a new study.

Regularly eating red and processed meats in particular is associated with a higher risk of type 2 diabetes, according to an analysis of data from 31 study cohorts published Tuesday in the journal The Lancet Diabetes & Endocrinology.

The study is the most comprehensive to date showing the link between processed meat and unprocessed [red meat with type 2 diabetes](#), said senior study author Dr. Nita Forouhi, professor of population health and nutrition at the University of Cambridge in the United Kingdom, in an email.

Type 2 diabetes, a chronic condition that occurs when your blood sugar is regularly too high, is the most common type of diabetes, according to the National Institute of Diabetes and Digestive and Kidney Diseases. If not managed, type 2 diabetes can lead to problems including heart disease, stroke and kidney disease.

There are more questions about meat that need to be asked, such as the risk from poultry and the possible effects of different cooking methods, said Dr. Hilda Mulrooney, reader in nutrition and health at London Metropolitan University, in a news release. She was not involved in the study.

But the new research does line up with current nutritional guidelines that recommend lowering meat consumption, Mulrooney said.

## A global look

The study was observational, so the researchers couldn't conclude that the consumption of meat was the direct cause of the diabetes, Mulrooney said.

But the connection was strong, said Forouhi, noting "these findings were consistent across populations in different world regions and countries."

Researchers analyzed data from nearly 2 million people across 20 countries. The team also accounted for factors including "diet quality, physical activity, smoking, alcohol intake, energy intake and body mass index that could impact the results and that may otherwise exaggerate or mask the relationship of meat and type 2 diabetes," Forouhi added.

However, the data did not allow researchers to account for other things that may contribute to type 2 diabetes, including family history, insulin resistance and waist circumference, according to Dr. Duane Mellor, dietitian and spokesperson for British Dietetic Association and honorary academic fellow at Aston University in the United Kingdom. He was not involved in the research.

Those factors are more strongly associated with risk of developing diabetes than the factors the researchers were able to account for, he added in a news release.

"It is possible that the increased risk associated with processed and red meat intake could be a result of these other confounding factors," Mellor said.

## More plants, less meat

Even with those limitations, the evidence in the new study and current dietary recommendations do make a strong case for cutting back on meat, Mulrooney said.

“Meat consumption generally exceeds dietary guidance,” she said. “Current dietary guidance also recommends replacing red and processed meats with meats such as poultry, in addition to reducing overall meat consumption using alternatives such as peas, beans, lentils and tofu.”

Although there is not clear research yet into whether poultry consumption and type 2 diabetes risk are connected, the recent study showed that replacing red meat and processed meats with poultry did result in a lowered risk of developing type 2 diabetes, Mulrooney added.

“It is well known that generally the available processed meat such as ham, sausages, bacon, hot dogs, salami or pepperoni are highly processed, containing chemical additives as well as being high in salt, making them unhealthy for a wide range of health conditions,” Forouhi said.

There are many ways to cut down, including, “eating these meats less often, having smaller portions, or swapping them for alternative foods rich in proteins,” she added.

And in addition to striving for a diet high in vegetables, fruits, nuts and beans, people concerned about diabetes should make sure to [incorporate regular exercise](#), Mellor said.

## **A vegan diet can reduce your biological age, new study finds**

Scientists have found that a vegan diet may be the solution to fighting old age.

[A plant-based diet](#) may reduce a person’s biological age, the new research suggests.

After eight weeks, there were also decreases in the ages of the heart, hormone, liver, and inflammatory and metabolic systems, the study found. These changes were not seen in those whose diet included [meat](#), eggs, and dairy.

Those who ate a vegan diet also lost two kilogrammes more on average than those who ate did not, due to them consuming 200 fewer calories through the meals provided during the initial four weeks of the study.

According to the experts, the weight loss could have contributed to the observed differences in biological age between both groups.

Some experts suggest that, long-term, a vegan diet may result in nutritional deficiencies and may not suit all ages, while others say the differences could have been down to the weight loss.

The findings are based on a small study of 21 pairs of identical twins aged 39, half of whom ate a vegan diet, while the other sibling ate an omnivorous diet.

By the end of the study, the researchers observed decreases in biological age estimations based on levels of DNA methylation – a type of chemical modification of DNA that is used to estimate biological age.

Biological aging refers to the decline in functioning of tissues and cells in the body, as opposed to chronological age.

Previous research has reported that increased DNA methylation levels are associated with aging.

However, Varun Dwaraka, of epigenetic testing company TruDiagnostic Inc, and Christopher Gardner of Stanford University, California, and colleagues, said it is unclear how much the differences between the pairs can be attributed to the differences in diet.

Further research is needed to investigate the relationship between diet, weight and aging, in addition to the long-term effects of vegan diets, they add.

Tom Sanders, Professor emeritus of Nutrition and Dietetics, King's College London (KCL), who was not involved in the study, said the research found some difference in terms of aging for vegans, but does not consider the fact that vitamin and mineral deficiencies often take years to appear.

He added that research also suggests a vegan diet may not be good for the health of older people.

Prof Sanders said: "Although observational studies indicate that vegan diets may have favourable effects on health in middle age (such as a lower risk of cardiovascular disease and type 2 diabetes), this is not the case in older vegans who seem more likely to suffer from muscle loss, low bone density and neurological disorders which have a significant impact on the quality of life.

"Indeed, life expectancy does not differ in vegans compared with those who select mixed diets."

Dr Duane Mellor, dietitian and spokesman for British Dietetic Association, said that although the study compared a vegan diet to an omnivorous diet, these diets were not entirely matched in terms of calories.

He explained: "It is possible that a reduction in energy intake could potentially have altered how the participants' DNA was changed."

Dr Mellor added that the vegan group were asked to eat twice the number of portions of vegetables, more fruit and more legumes, nuts and seeds than the omnivore group, which also could in part explain the differences reported.

The findings are published in the BMC Medicine journal.

**Scientists make breakthrough that could change the face of food production: 'It makes agriculture much more efficient'**





Researchers in Germany have developed a [technology](#) that uses microbes and carbon dioxide to produce materials that could help stabilize food supplies around the world.

According to Cell Press, as [Science Daily](#) shared, scientists have found a way to harvest proteins and vitamins from microbes by feeding them a diet of hydrogen, oxygen, and carbon dioxide.

"This is a fermentation process similar to how you make beer, but instead of giving the microbes sugar, we gave them gas and acetate," said corresponding author Lergus Angenent of the University of Tübingen, Germany. "We knew that yeast could produce vitamin B9 on their own with sugar, however, we didn't know if they could do the same with acetate."

The researchers created a two-stage bioreactor to produce their desired results. In the first stage, the bacteria *Thermoanaerobacter kivui* is fed carbon dioxide and hydrogen, which it converts into acetate. That acetate is then fed into the second stage of the reactor, containing baker's yeast, which feeds on the acetate and oxygen to produce both vitamin B9 and protein.

The amount of B9 and protein produced by the yeast is considerable, as well. Less than half a tablespoon of dried yeast contains your daily required value of B9, while the yeast produced more protein than beef, pork, fish, or lentils.

According to the study, six tablespoons of dried yeast contains 61% of the daily required protein for people, "while beef, pork, fish, and lentils meet 34%, 25%, 38%, and 38% of the need, respectively."

Angenent was quick to point out the possibilities of the research, particularly in light of our changing planetary climate.

"We are approaching 10 billion people in the world, and with [climate change](#) and limited land resources, producing enough food will become harder and harder," said Angenent. "One alternative is growing proteins in bioreactors through biotechnology rather than growing crops to feed animals. It makes agriculture much more efficient."

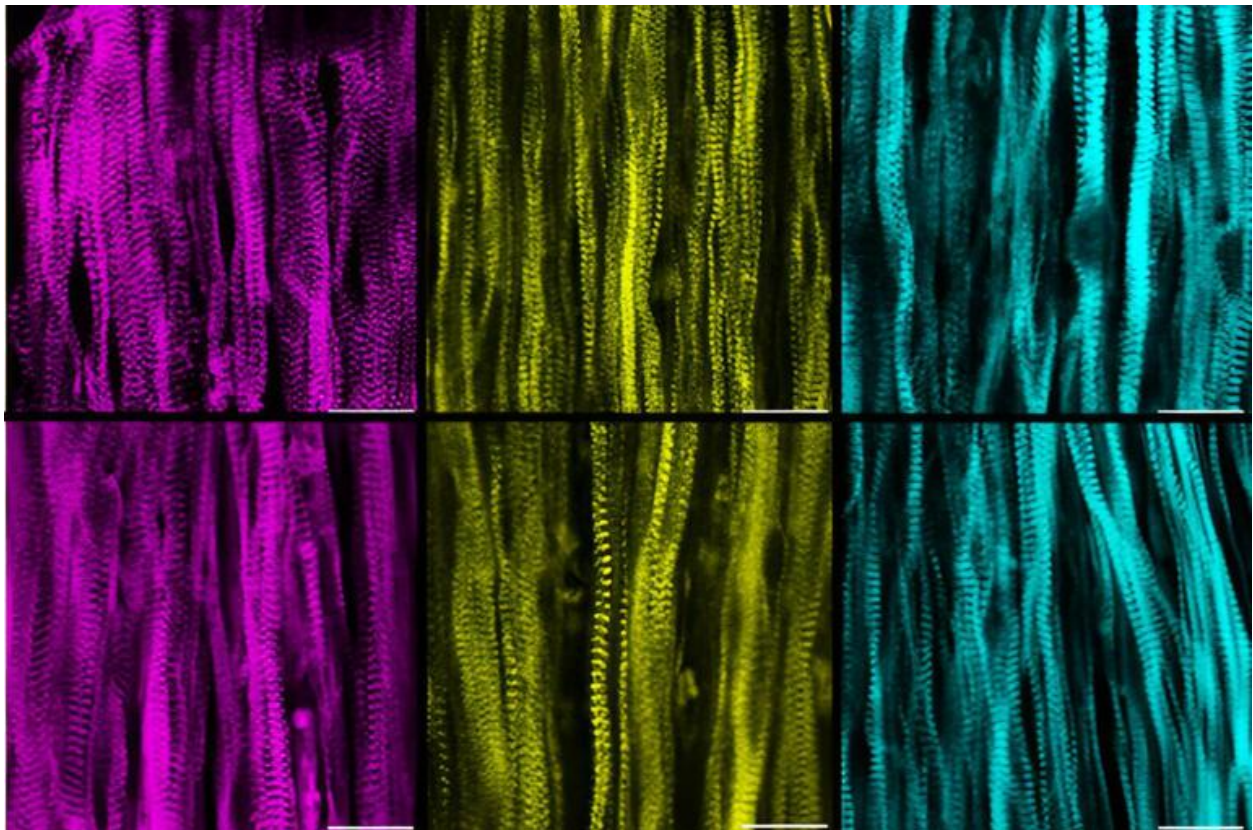
As our climate changes, it becomes essential for agriculture to adapt as well. Scientists have also [discovered](#) an agave plant that could thrive in polluted or

previously unusable soil. A team from Washington State University [discovered](#) it could filter nickel poisoning from the soil with specific microbes. And in Vietnam, people have [started turning](#) black soldier flies into viable animal feed and fertilizer.

For his part, Angenent believes there are a number of ways this technology could be implemented.

"The fact that we can make vitamins and protein at the same time at a pretty high production rate without using any land is exciting," Angenent said. "The end product is vegetarian/vegan, non-GMO, and sustainable, which could appeal to consumers."

## Lab-grown muscles reveal mysteries of rare muscle diseases



The top row of photos show a microscopic view of healthy muscle fibers stained to reveal a variety of irregularities, while the bottom row shows the same but for muscle fibers afflicted by the disease LGMD2B. Notice any differences?

Neither did the experts, revealing that the effects of the disease are not caused by physical malformations within the muscles. Credit: Alastair Khodabukus, Duke University© Provided by Medical Xpress

**B**iomedical engineers at Duke University have developed a new technique to better understand and test treatments for a group of extremely rare muscle disorders called dysferlinopathy or limb girdle muscular dystrophies 2B (LGMD2B). The approach grows complex, functional 3D muscle tissue from stem cells in the laboratory, creating a platform that replicates patient symptoms and treatment responses.

In their debut study, researchers reveal some of the biological mechanisms underlying the characteristic loss of mobility caused by LGMD2B. They also demonstrate that a combination of existing treatments may be able to alleviate some of the worst symptoms of the disease.

The [results](#) appear in the journal *Advanced Science*.

LGMD2B affects only about eight people per million around the world. Unlike its more well-known and more common cousin Duchenne muscular dystrophy, the disease affects both men and women, presents later in life—in the late teens or early 20s—and is rarely fatal. However, LGMD2B patients develop severe weakness in the legs and shoulders, typically requiring them to use wheelchairs for the rest of their lives.

Caused by a genetic disorder, LGMD2B stops the body from creating a fully functional form of a protein called dysferlin. There are currently no approved treatments or cures. Part of the reason for this lack of options is the many functions of dysferlin, including sealing holes in muscle membranes, regulating calcium balances required for muscle contraction and controlling cellular metabolism. And for reasons unknown, affected muscles initially accumulate fat within the muscle fibers themselves before degenerating and ultimately being replaced by fat cells.

An array of Petri dishes each housing a platform for growing muscle fibers from stem cells. The Bursac Lab was the first to grow contracting, functional human skeletal muscle in a Petri dish and has been improving its processes ever since to enable studies of muscle strength, metabolism and repair. Credit: Alastair Khodabukus, Duke University© Provided by Medical Xpress

"This phenomenon is very rare even for muscular dystrophies," said Nenad Bursac, professor of biomedical engineering at Duke. "It's a burning question within the community of why that happens."

One of the challenges facing researchers trying to solve these problems is that the mouse model used to approximate LGMD2B shows very mild symptoms compared to patients. Mice with the disease are still able to walk, and it does not present until nearly a year into their two-year long lifespan, making studies of the disease extremely slow.

Dysferlin is expressed in other cell types, and blood levels of metabolic fuels such as cholesterol are also altered in mice and patients. Together, this complicates LGMD2B research by making it difficult to assess what cell types are responsible for the disease and if metabolic changes are due to the loss of dysferlin itself or whole-body effects.

To get around these challenges, Bursac and his research scientist Alastair Khodabukus turned to an engineered muscle platform that they have been developing for nearly a decade. The Bursac Lab was the first to grow contracting, functional human skeletal muscle in a Petri dish and has been improving its processes ever since to enable studies of muscle strength, metabolism and repair. This system allowed them to focus their study on only the effects of dysferlin on skeletal muscle without the complications of other cell types or altered blood metabolite profiles.

In the study, the researchers began with induced pluripotent stem cells (IPSCs) derived from patients living with LGMD supplied by The Jain Foundation, a charity focused on finding a cure for LGMD2B. Using their muscle-growing techniques, the lab matured these stem cells into muscle fibers and ran them through a battery of tests over the course of six weeks.

Like muscles found in patients themselves, the lab-grown versions displayed a wide variety of issues.

"Overall, our model repeated a lot of the clinical manifestations of the disease and observations made in real patients, but it was all done in a Petri dish," said Bursac. "We've been able to gain new insights into the muscle-specific aspects of the disease."

The researchers discovered that the loss in muscle strength was not the result of deficiencies in muscle structure or size, but in its handling of calcium. Muscle contractions are physically caused by reservoirs of calcium in muscle cells being released and binding to muscle proteins. Tests showed that the diseased muscle cells had sprung leaks in their calcium reserves, resulting in less calcium to release and weaker contractions.

The researchers also showed that the lack of dysferlin caused damage to the muscle cells to go unrepaired, and that an inability to burn fatty acids for energy production was at least partially to blame for the accumulation of fat within muscle fibers that has long puzzled the medical community.

"We replicated something seen in patients and showed that it's not due to environmental factors within the body, but issues within the muscle itself," Khodabukus said.

The researchers then tested the effects of two drug candidates to potentially treat the disease that have been identified through mouse models but have not yet been tested in humans. One called dantrolene is supposed to stop calcium from leaking from muscle cells' reservoirs. The second, called vamorolone, was recently approved for use with Duchenne muscular dystrophy patients, although researchers do not fully understand how it works.

Together, the drugs prevented the calcium leak and helped the cell membrane repair itself, restoring much of the muscles' strength. And while they also helped reduce the amount of fat accumulated within the muscles, they did not fully prevent it, nor did they help the muscles efficiently burn fats for fuel.

Moving forward, the group is planning to add immune and fat cells to their experiments for greater complexity. They also are looking to further understand disruptions to cellular metabolism and to find new drugs that fully restore all strength, repair and metabolic deficit.

"Right now, we have a basic muscle-only system, which is great to see the effects of the disease within the muscle itself, but what is also important is the crosstalk between immune cells, fat cells and muscle cells," Khodabukus said. "By building out our system more, we'll hopefully be able to fully figure out what is driving the loss of muscle and its replacement by fat in these patients."

**More information:** Alastair Khodabukus et al, Bioengineered Model of Human LGMD2B Skeletal Muscle Reveals Roles of Intracellular Calcium Overload in Contractile and Metabolic Dysfunction in Dysferlinopathy, *Advanced Science* (2024). [DOI: 10.1002/adv.202400188](https://doi.org/10.1002/adv.202400188)

Provided by Duke University

## **Lab-made muscle: New laser tech grows real human tissues to replace lab rats**

Think of a future where injuries heal faster, diseases are cured more effectively, and lab-grown meat is a reality. This future is one step closer, thanks to the innovative work of Dr. Hao Liu from ETH Zurich.

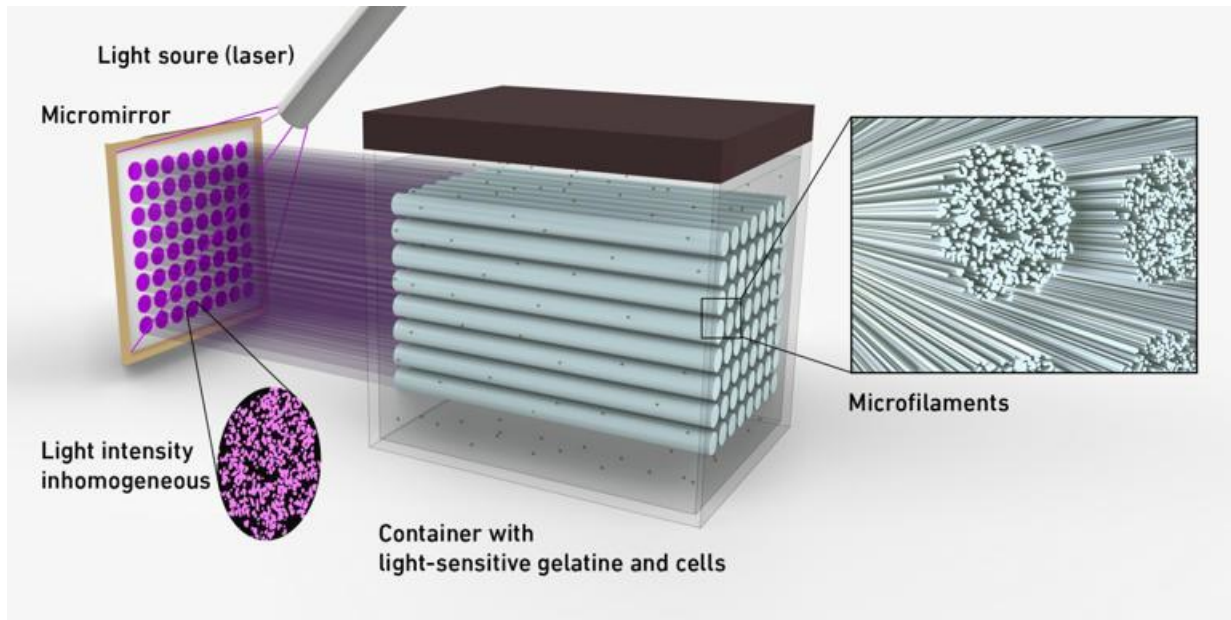
Liu uses laser technology to create intricate, microscopic structures that mimic the natural architecture of human tissues.

These structures, made from a special type of gelatin, serve as scaffolds for growing cells. By carefully controlling the laser, Liu and his team can create highly aligned microfilaments (protein filaments). The filaments replicate the precise structure found in tissues like muscles, tendons, and nerves.

For this, the researchers have created a compact bioprinter to develop biological tissues with microfilament structures. He is now working to bring this technology to market.

“Our aim is to create human tissue models for high-throughput drug screening and other applications,” Liu said.





## Creating biological tissues

The human body is composed of various tissues, each with specific structures and functions. These tissues, like muscles, tendons, connective tissue, and nervous tissue, exhibit organized cellular arrangements. This organization is crucial for their proper functioning.

To replicate natural tissue structures in the lab, researchers create 3D scaffolds using bioprinters. These scaffolds serve as a template for growing cells, resulting in perfectly structured tissue.

Engineered tissues can be used for various purposes, including surgical replacements, medical research, and food production. Interestingly, they can repair damaged nerves, model diseases for drug testing, and produce lab-grown meat.

In this work, Liu first printed tissue scaffolds and then used a novel method to create highly aligned, fine filaments.

He utilized a light-sensitive gelatin, which transitions from liquid to solid when exposed to laser light.



“Where we expose it with a laser, it solidifies into hydrogel. Wherever the laser can’t reach, the gelatine remains liquid,” Liu said.

He successfully created microfilaments within the hydrogel, comparable in size to the fibrous components found in natural tissues. Subsequently, he cultivated cells on this scaffold to generate aligned tissue structures.

## Laser beam phenomenon

The filamented light (FLight) 3D bioprinter utilizes a unique optical phenomenon to create highly aligned microfilament structures within a hydrogel matrix.

Laser beams exhibit uneven light intensity, with areas of high and low energy.

When a light-sensitive material is exposed to such a beam, it solidifies unevenly, forming parallel, thread-like structures with channel-like spaces between them.

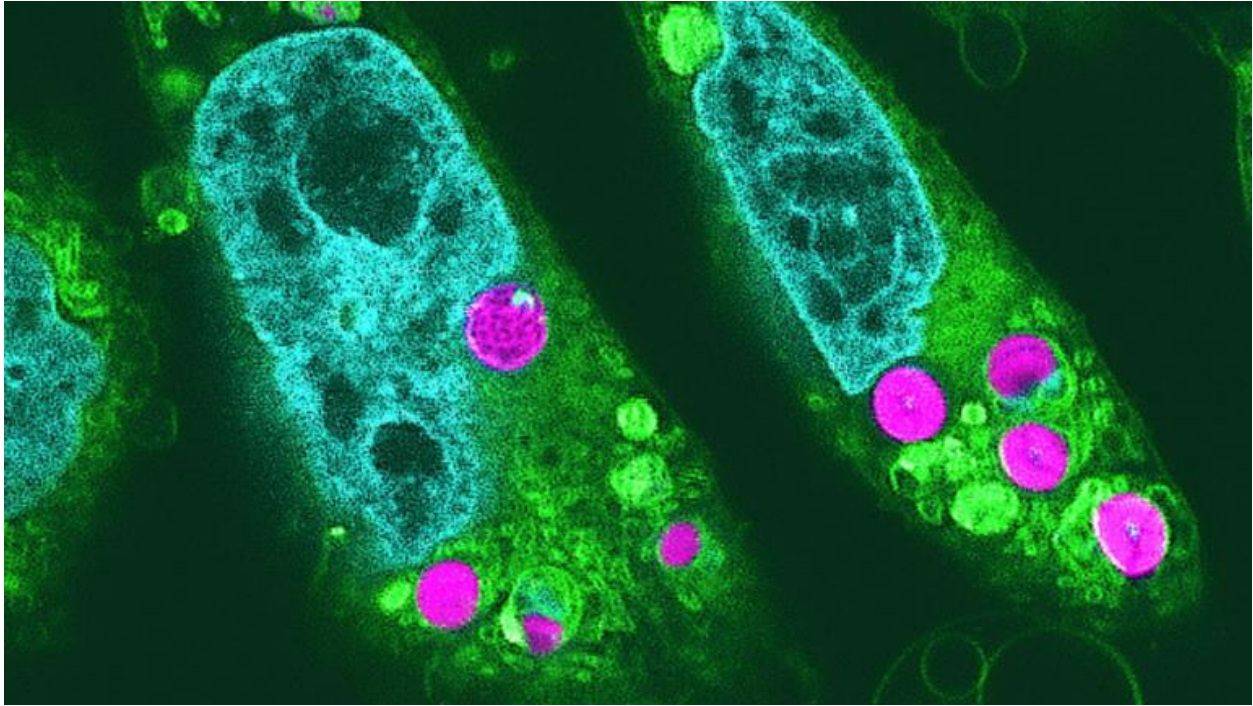
These structures, with diameters ranging from 2 to 20 micrometers, mimic the natural arrangement of many body tissues. When cells are introduced into these scaffolds, they grow along the channels, resulting in aligned [tissue](#) constructs.

“The optical phenomenon that creates the filament microstructures in the gel has long been known to physicists and material scientists. But it hadn’t yet been used in biology; we’re the first,” Liu said.

Utilizing this printing method, the team has produced tissue constructs similar to [muscle](#), tendon, nerve, and cartilage tissues. ETH Zurich has patented this technology.

# First-ever solar-powered photosynthetic animal cells created in lab using algae

By incorporating chloroplast-infused cells, researchers could supply oxygen via light exposure, creating better growth conditions for complex, multi-layered tissues such as [lab-grown organs](#) or meat.



First-ever solar-powered photosynthetic animal cells created in lab using algae

Japanese researchers have achieved a breakthrough by inserting energy-generating chloroplasts from algae into hamster cells, allowing these animal cells to photosynthesize.

Previously, it was believed that chloroplasts, which are light-capturing structures essential to plant and algae cells, could not function within animal cells. However, the chloroplasts survived and performed photosynthetic processes for at least two days, potentially paving the way for advances in tissue engineering.

"As far as we know, this is the first reported detection of photosynthetic electron transport in chloroplasts implanted in animal cells," said Professor Sachihiro Matsunaga of the University of Tokyo, corresponding author of the research paper.

This technique could address oxygen shortages that hinder lab-grown tissues, such as artificial organs and skin, by allowing light exposure to generate oxygen and energy for cell growth.

## Can animal cells photosynthesize?

The idea of animal cells adopting photosynthetic abilities may sound like science fiction, but some animals, like giant clams, already benefit from partnerships with photosynthetic organisms.

These clams harbor algae that use chloroplasts to photosynthesize, providing oxygen and food to their host. Inspired by such natural relationships, the researchers explored whether animal cells could functionally incorporate chloroplasts themselves.

"We thought that the chloroplasts would be digested by the animal cells within hours after being introduced," said Matsunaga.

"However, what we found was that they continued to function for up to two days, and that the electron transport of photosynthetic activity occurred," he added. This electron transport is essential for the chemical energy production needed in plants and algae, suggesting that the chloroplasts were indeed working within their animal cell hosts.

## Making animal cells produce fuel

In the study, red algae chloroplasts were placed into cultured hamster cells, which were then analyzed with imaging techniques like confocal and electron microscopy. Photosynthetic activity was measured by pulse amplitude

modulation fluorometry, confirming that the chloroplasts were effectively producing energy within their new host cells.

The animal cells containing chloroplasts even showed an increased growth rate, suggesting that the photosynthesis process supplied them with [carbon-based fuel](#).

“We believe this work will be useful for cellular-tissue engineering,” Matsunaga noted. “Lab-grown tissues, such as artificial organs, artificial meat, and skin sheets, are made of multiple layers of cells. However, they cannot increase in size due to hypoxia (low oxygen levels) inside the tissue, which prevents cell division.

“By mixing in chloroplast-implanted cells, oxygen could be supplied to the cells through photosynthesis, by light irradiation, thereby improving the conditions inside the tissue to enable growth,” he explained.”

## Looking ahead

By incorporating chloroplast-infused cells, researchers could supply oxygen via light exposure, creating better growth conditions for complex, multi-layered tissues such as [lab-grown organs](#) or meat.

Looking ahead, Matsunaga and his team hope to develop these “planimal” cells further, enabling beneficial plant-like traits in [animal](#) cells. “We expect planimal cells to be game-changing,” Matsunaga said in the [press release](#), envisioning future biotechnologies that could lead to a more sustainable society and help reduce carbon emissions.

Future studies will focus on understanding the substance exchanges between host cells and chloroplasts, potentially unlocking new pathways for artificial tissue development and sustainable biotechnologies.

The study has been published in [Proceedings of the Japan Academy](#).

# Researchers Transfer a Human Protein Into Plants to Supersize Them



While a promising route to boosting crop yields, experts say more work needs to be done to understand why the tweak works

Every year, 9 million people in the world succumb to hunger-that's more than the deaths from AIDS, malaria and tuberculosis combined. But the solution to the global hunger crisis isn't as simple as ramping up agricultural production.

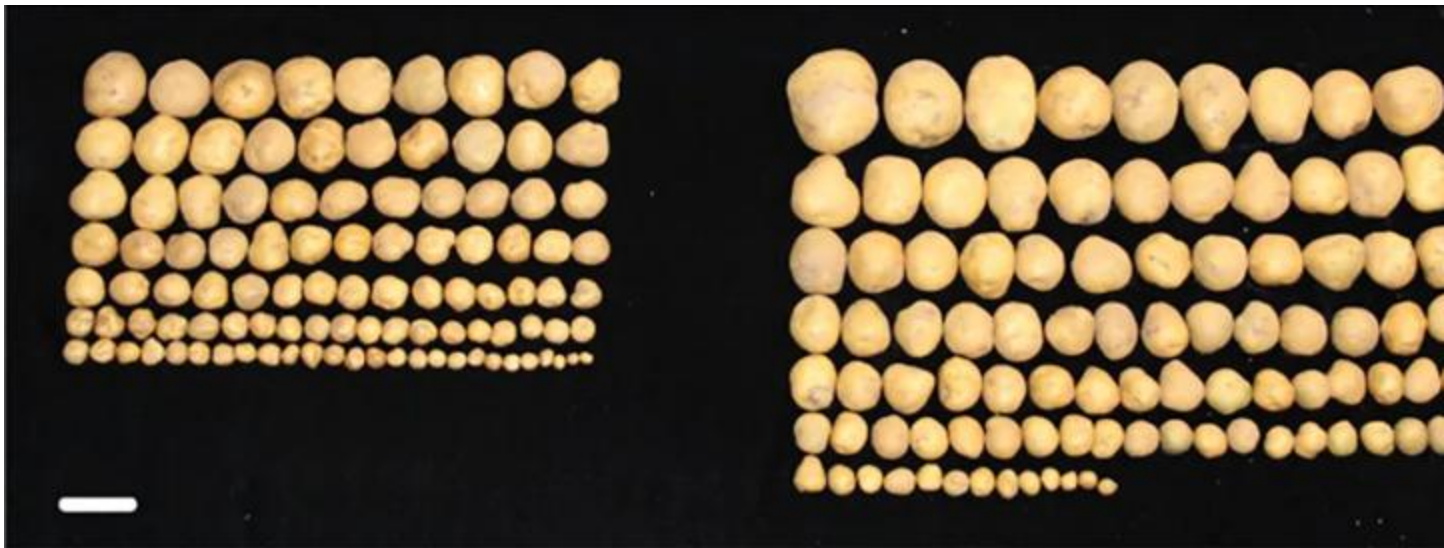
For one, agriculture comes with a hefty carbon footprint, contributing 10 to 20 percent of the global greenhouse gases annually. Then, chemical overuse sows resistance in the pests and pathogens the substances intend to kill, making it harder for farmers to eradicate their associated diseases the next time around. Runoff from fertilizers may also pollute waterways.

It's not enough to grow more food-humanity needs to grow more efficiently.

With an eye toward feeding the world's growing population in a sustainable way, researchers from China and the U.S. may have found a clever solution-in the form of supersizing crops. Transplanting a human protein, known for promoting growth, into crops may engender larger, heavier and more bountiful plants, boosting agricultural yields by a whopping 50 percent, according to the new study in *Nature Biotechnology*. While the results are promising, experts say that



more research needs to be done to test their agricultural mettle and ensure that the gains are replicable.



Equipped with the genetic machinery to produce a human growth protein, potato plants can churn out hunkier tubers (right). The scale bar denotes 4 inches. Qiong Yu et. al.

"We think this is a very good strategy to engineer our crops," says study author Guifang Jia, a chemical biologist at Peking University in Beijing, China. But she admits "this paper is an initial study." She wants to run many more follow-up tests, including safety evaluations, before the team's prodigious produce can end up on the dinner tables of everyday consumers.

The protein responsible for the plants' extraordinary growth spurt is the human fat mass and obesity-associated protein called FTO. While its associated gene gets a bad rap for increasing one's obesity risk, the researchers previously reported that the protein is important for regulating growth in humans and other mammals. According to the researchers, FTO chemically modifies RNA strands, which are the short genetic recipes for individual proteins copied right out of the DNA playbook. This modification forces the RNA to produce the protein it encodes for. Essentially, FTO acts as a master "on" switch that ramps up widespread protein production across multiple RNA strands.

Several authors of the study had spent a decade understanding the role of FTO in humans. The researchers wondered what would happen if this RNA-targeting, growth-promoting protein made its way into plants instead.

"It [was] really a bold and bizarre idea," says study author Chuan He, a chemist at the University of Chicago. The human body produces tens of thousands of

proteins, and the first one his group tried in plants was FTO. "To be honest, we were probably expecting some catastrophic effects."

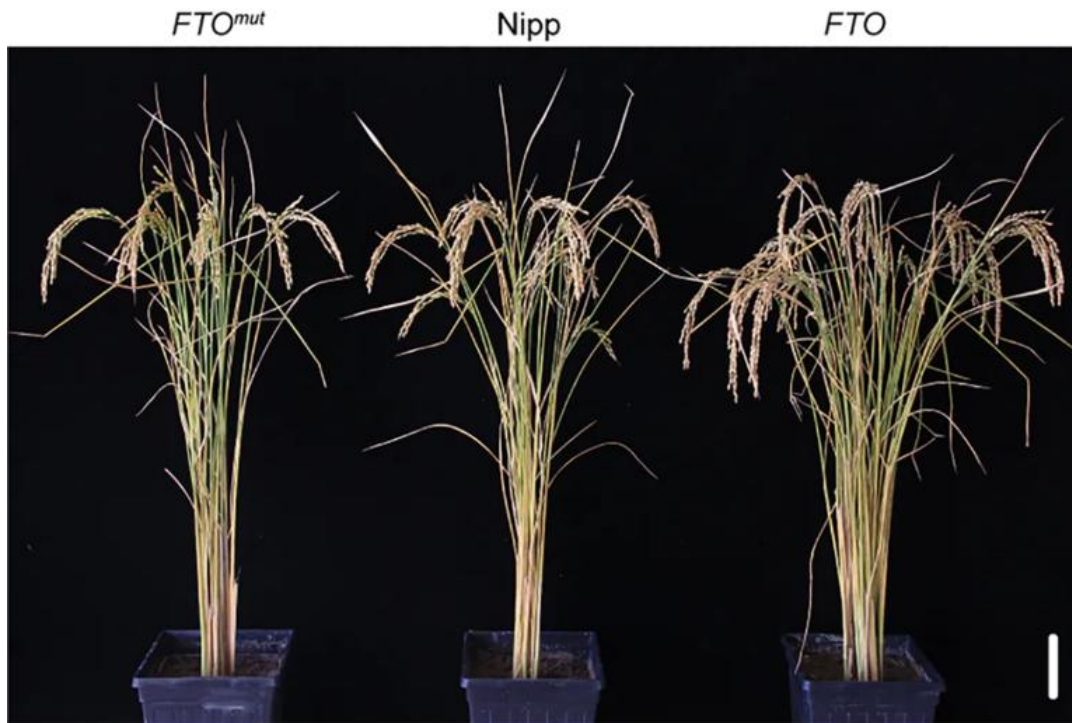
Plants do not have an FTO-equivalent protein, says He. The chemist suspects that plants usually keep growth under a tight rein to prevent any one molecule from single-handedly wreaking havoc on a plant's physiology. But in the face of a foreign protein, He says that plants lack any checks and balances to temper the consequences, whatever they may be. To the researchers' surprise, FTO doesn't kill off or cripple the plant. Instead, it forces plants to do the exact opposite: size up.

"[FTO] comes in, and there's no restriction to where it can access," says He. "It's a bomb."

The researchers implanted the human FTO gene into the genomes of rice crops, allowing the plants' protein machineries to take over and churn out this human molecule on its own. In the greenhouse, the genetically modified crops produced three times more rice than the untweaked plants. Grown out in fields in Beijing, the rice plants were 50 percent heavier and more productive. The same genetic modification also upsized the tubers of potato plants. Plants spiked with FTO also grew longer roots, showed higher photosynthesis levels and were more resistant to droughts.

Every type of plant the researchers altered, including grass and trees, grew faster and bigger. "This phenotype [trait] is consistently in any plant we engineer," says Jia.





FTO-equipped rice plants, as shown on the right, produce more bountiful harvests. The scale bar denotes four inches. Qiong Yu et.al.

Despite its promise, genetic modification hasn't been able to reliably amplify crops yields by more than 10 percent. Plant growth is complicated, genetically speaking-there simply isn't one single gene to tweak. The study's jaw-dropping percentage increases are amazing, almost unbelievably so, and other plant researchers recommend caution before getting any hopes up and ascribing more power to the protein.

"What's unusual about the strategy taken in this paper is that there is no reason to expect that it would have been successful," says Donald Ort, a plant biologist at the University of Illinois at Urbana-Champaign who didn't participate in the study. Science usually inches forward by building upon well-understood theories, says Ort. But the authors of the study seemed to have taken a stab in the dark and struck gold. "My guess is they were pretty surprised," he says.

The study's remarkable percentage increases in yield are much higher than the blips of several percentage points other researchers usually squeeze out, say Robert Sablowski, a plant biologist at the John Innes Center in the U.K. who wasn't involved in the study.

"The final yield of a crop is genetically a very complex trait," he says. Plants are constantly shifting priorities between bulking up or beefing up their defenses against diseases and stretches of unfavorable growth conditions. A plant's surroundings usually have a large say in determining the final yield, but the study's result seems to override most of these influences. "Because of all these compromises, it's very unusual to read a report of a very high yield increase with a simple genetic change," Sablowski adds. "But it's possible." He says he would like to see the results replicated in different kinds of environmental conditions, and to better understand how the human FTO protein upends the carefully calibrated inner workings of a plant.

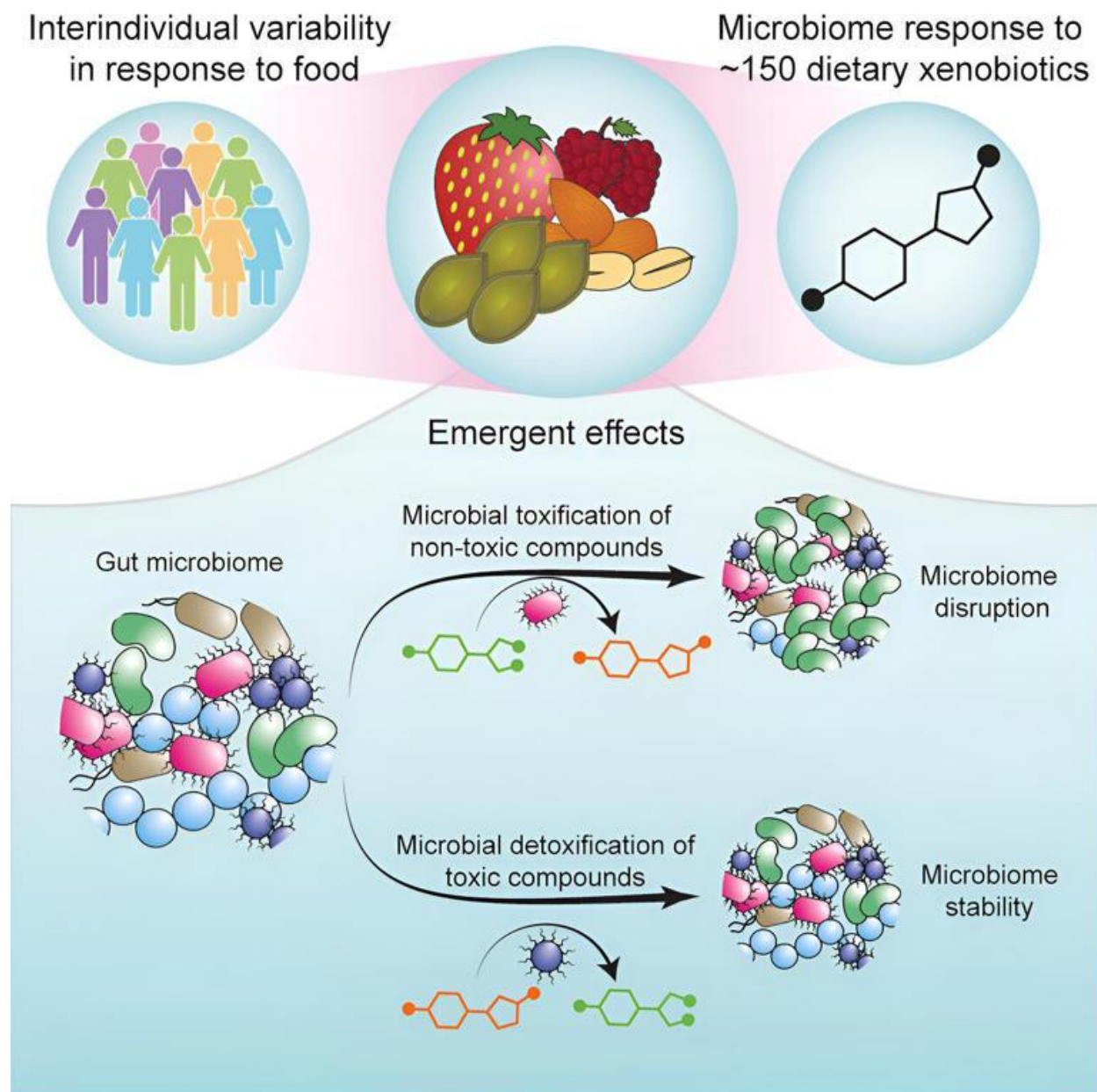
By absolute numbers alone, the FTO-modified rice and potato plants reported in the study have lower yields than commercial varieties, says Ort. Only if the same FTO trick increases the productivity of these already high performing strains, then that would be a true breakthrough. "The potential importance of this to agriculture still remains to be proved," says Ort.

Both Ort and Sablowski are cautiously optimistic, because the path forward is clear: repeat the experiments elsewhere and with the best crop varieties humanity has to offer.

Jia and He are already on the chase—they're working with farmers and probing deeper into the genetic mechanisms. But these experiments will take time, says Jia. Her team lost a growing season to last year's lab shutdowns from the pandemic. She estimates her team will need several years to collect enough seeds from the handful of genetically tweaked parents to sow entire fields with their progeny.

The team is also experimenting with other non-plant proteins. So far, they've tried one other candidate, but didn't see the same crop yield increases as wrought by the FTO protein. "I suspect it's probably not going to work," says He of other proteins. The regulatory pathways of plants are usually robust; it's not common that scientists find a bug in their code that brings about biological bedlam. "I think FTO is very special," says He.

# Molecular map points the way toward better food choices



"Gut health" is a growing buzzword for foodies and dietitians alike—and with good reason. The trillions of microbes and bacteria living in our gut are implicated in numerous aspects of health and disease.

Scholars at the Yale Microbial Sciences Institute have taken an important step toward evidence-driven personalized nutrition tailored to individual gut health needs.

The lab of Andrew Goodman has generated the first systematic map to show how the molecules in certain foods interact with our unique gut bacteria. Their findings are [published](#) in the journal *Cell*.

Building on earlier research examining medical drugs and gut bacteria, the scientists set out to understand why different people respond differently to the same foods.

"We know that diet is a huge component of our health and shapes our microbiome," explained Elizabeth Culp, a former postdoctoral fellow in the Goodman Lab and first author of the study.

While a large body of work has described the effects of "macronutrients" such as fiber on our gut microbiomes, surprisingly little is known about how other small molecule components in food drive health issues.

"Aside from anecdotal examples in the scientific literature, evidence is scarce regarding which dietary changes people can make to help them manage risk factors for diseases like diabetes or cancer," said Culp.

"It is possible this is because our microbiomes respond differently to the same molecules present in food."

The scholars designed a systematic map of the interactions between small molecules in our food and different bacteria in the gut.

The work is among the first to describe the specific microbial genes responsible for metabolic transformation of dietary compounds and the mechanisms for how dietary compounds change our microbiomes.

Using liquid chromatography-mass spectrometry at the Yale West Campus Analytical Core, the scientists combined different molecules with gut bacteria to create growth models and maps for around 150 dietary "xenobiotic" compounds. Sequencing at the Yale Center for Genome Analysis enabled the team to measure the degree of change in the composition of human gut communities.

"We were surprised by the level of variability," said Goodman, who is the C.N.H. Long Professor and Chair of Microbial Pathogenesis, and Director of the Microbial Sciences Institute (MSI).

"The same dietary compound could dramatically reshape some individuals' gut microbial communities while having almost no impact on other people's microbiomes,"

The molecular map provides a mechanism to explain these variable responses between different people, showing how a dietary compound impacts the growth of gut microbes and how that compound is metabolically altered by the microbial community.

Predicting how an individual responds to a given food—and ultimately how this affects their health—remains difficult. But the findings offer a foundation to understand how metabolic reactions vary between people and how these differences shape the growth of "good" or "bad" bacteria in our gut.

"If we can figure out the specific microbial genes that determine how a microbiome responds to a molecule in our food, and how these genes are different between different people's microbiomes, correlations to diseases like cancer, diabetes, or gastrointestinal infections can start to make sense," concludes Culp, who is currently a scientist at Empress Therapeutics in Boston.

"This is the first step towards creating custom dietary recommendations as part of personalized nutrition strategies."

**More information:** Elizabeth J. Culp et al, Microbial transformation of dietary xenobiotics shapes gut microbiome composition, *Cell* (2024). [DOI: 10.1016/j.cell.2024.08.038](https://doi.org/10.1016/j.cell.2024.08.038)

Provided by Yale University

## 6 Unexpected Consequences of Eating Too Much Protein

Feeling tired, having wounds that won't heal, and weak muscles might be signs you're not getting enough protein, warns dietitian Vandana Sheth, amid the growing buzz about this nutrient on social media.

While proteins are essential for our bodies, overdoing it can have some not-so-great side effects. Did you know that a high-protein diet can throw your nutrition out of whack and mess with your health? Find out the signs that you're overloading on protein and how to strike the perfect balance.

### How Much Protein Should We Eat Daily?

Protein is an essential nutrient our bodies need to build and repair tissues. The ideal amount varies for each person, but as a general rule, experts recommend consuming about 0.36 grams of protein per pound of body weight. However, this is a basic estimate, and your needs might be higher if you exercise regularly, are pregnant or breastfeeding, or are recovering from an injury.



The body can't store protein, and once it meets its needs, any extra is used for energy or stored as fat.

During pregnancy, protein needs increase significantly, requiring at least 0.5 grams of protein per pound of body weight daily. Older adults also have higher requirements, needing about 0.54 grams per pound of body weight. Athletes,



due to their higher muscle wear and tear, demand even more, needing up to 0.82 grams per pound of body weight.

Protein requirements are highly individualized and vary based on factors like physical activity level, occupation, health status, and age. As Sheth points out, it's crucial to determine each person's specific protein needs through a personalized nutritional assessment conducted by a nutrition professional.

## Can Eating Too Much Protein Be Harmful?

Nutrition experts warn about the potential adverse effects of excessive protein intake, particularly from animal sources like red meat. Health organizations such as the American Heart Association and the American Cancer Society have linked high red meat consumption with an increased risk of cardiovascular diseases and certain types of cancer. Sheth cautions that consuming too much protein can have negative health consequences, from kidney problems to digestive issues and weight gain.

Consuming more than 0.9 grams of protein per pound of body weight daily, unless you have a specific physiological need (like high-performance athletes or people with certain medical conditions), can be harmful to your health. Although this figure is a general estimate, it's a good starting point to assess if you're overdoing it with this macronutrient.

## These Are the Symptoms of Protein Overload

- Dehydration
- Increased urination
- Kidney stones
- Diarrhea
- Constipation



- Weight gain (since protein-rich foods are often high in calories)

It's essential to diversify your diet by incorporating more lean proteins, fiber, complex carbohydrates, vitamins, minerals, and healthy fats. This comprehensive nutritional strategy will help you achieve optimal nutritional balance and improve your overall well-being.

## I'm from Japan, home to some of the world's longest living people: The No. 1 food I must have in my kitchen

Story by Michiko Tomioka, Contributor



Here I am at an event about longevity at my local library.

Growing up in Nara, Japan, one food that was a constant in my home was [tofu](#). It's truly been a lifelong staple.

When I was a baby, once I could eat solids, my mom commonly prepared two dishes for me — one was a mix of tofu, rice porridge, sweet potato, *kabocha* (squash), and *nori* (seaweed) paste, and the other was miso soup with rice porridge.

I carried on that [culinary tradition](#) with my two kids when they were small. I never bought any [ultra-processed](#) baby food; instead I opted for tofu. It saved me time, money and stress, and it was a way for us to connect with our roots while living in the U.S.

***DON'T MISS: [How to master your money and grow your wealth](#)***

When we arrived here in 1994, tofu was harder to come by. If I could only find shelf-stabilized packaged versions, I kept about two dozen of them in the house at any given time. Even today, I always have several packs of tofu in my refrigerator.

In Japan, tofu is enjoyed by folks of all ages. My in-laws are 95 and 88 years old. They still live in Nara, and have tofu, *natto* (fermented soybeans) and miso soup every day. They attribute their [longevity](#) and immunity, in part, to that daily routine.

Here is why tofu is my No. 1 kitchen must-have.

### **1. It has a multitude of health benefits**

Tofu is traditionally made from soybeans and *nigari*, the liquid that remains after removing the salt from seawater. In the U.S., calcium sulfate is often used as the main coagulant.

Either way, tofu contains all the essential [amino acids](#) that meat, poultry, eggs, fish and dairy do — but [without cholesterol](#), since it is plant based.



Grilled tofu with nori flakes.

It also is rich in calcium, iron, vitamins, fiber and [isoflavones](#), a type of plant estrogen.

Studies have shown that the consumption of tofu can help [reduce the risk of heart disease](#), [fight cancer](#) and [reduce the risk of bone loss](#).

## **2. It's economically and environmentally friendly**

It takes 70.6 kilograms of greenhouse emissions to produce just one kilogram of beef, but only 3.2 kilograms of emissions to produce [the same amount of tofu](#).



One of my latest recipes, a tofu cabbage roll.

I typically purchase 14 ounces of organic tofu for \$2 or \$3, which is often much less than the same amount of poultry or beef would cost me at the grocery store.

To me, it is simple math. In the course of the week, if you were to swap out one or two beef burgers for a tofu burgers, you would feel better, pay less for groceries and do something small to help the environment.

## **3. It is delicious and versatile**

Tofu has a very natural, subtle flavor, so it can be matched with just about any cuisine or dish. Since it's soft, you can also prepare it without a knife and cutting board.

As a nutritionist and cooking instructor, I am always developing new recipes, and tofu makes it very easy to experiment.

I serve tofu in a variety of ways: pan-fried or in soups and salads, in *nimono* (slow cooked roots and veggies), dumplings, veggie pancakes, vegan curry, burgers, cabbage rolls, mochi and ice cream, to name a few.



A delicious tofu chocolate pudding.

My go-to lunch is a tofu miso soup with seasonal roots and leafy vegetables, seaweed, ginger and goji berries. Generally, I make a large pot and return to it throughout the week, serving it with multigrain rice, *natto* and *nukazuke* (pickles).

My other perfect, simple meal is *hiyayakko*. It is cold tofu — usually the silken or soft variety — topped with *nori*, sesame seeds, ginger, *shiso*, scallions, *natto* and a little bit of soy sauce. If you prefer it warm, you can always pop it into the microwave for one to two minutes and then add your toppings.

I often call tofu my best friend for happy living. I hope you are inspired to incorporate it into your kitchen, too.

[Michiko Tomioka](#), MBA, RDN, is a certified nutritionist and longevity expert. Born and raised in Nara, Japan, her approach focuses on a plant-based diet. She has worked in nutritional roles at substance recovery centers, charter schools and food banks. Follow her on Instagram [@michian\\_rd](#).

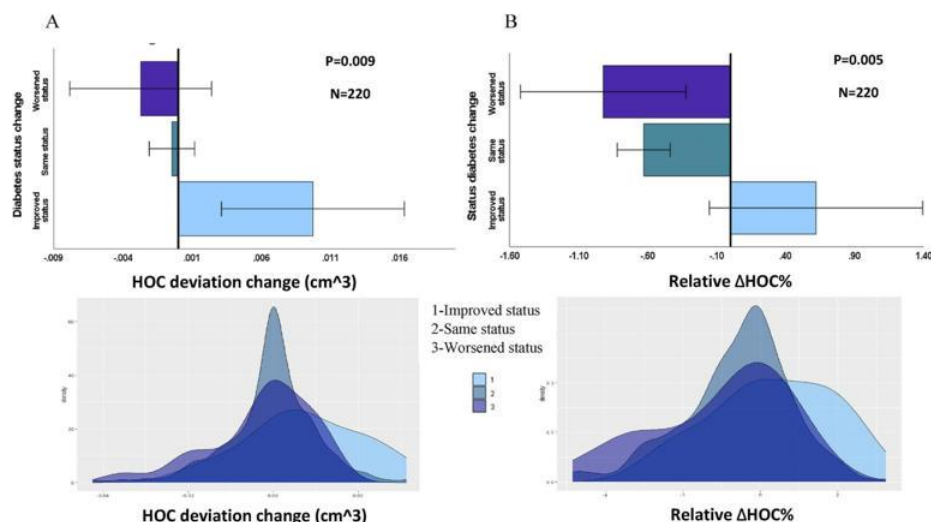
## Mediterranean diet may delay brain aging, study finds

Age-related brain atrophy, or the gradual loss of brain volume over time, is a natural part of aging that leads to cognitive decline and neurological issues. However, groundbreaking research has revealed that lifestyle changes, particularly diet, may hold the key to slowing this process.

An international team of scientists from [Ben-Gurion University of the Negev](#), [Harvard University](#), [Leipzig University](#), and others have made significant strides in understanding how diet influences brain health. Their findings, published in [The American Journal of Clinical Nutrition](#), suggest that better blood sugar control may be a powerful tool against age-related brain deterioration.

This study, part of the extensive DIRECT PLUS Brain MRI trial, focused on the biological age of the brain—distinct from chronological age—measured through brain imaging. Brain age represents the health of the brain and can sometimes deviate significantly from the actual age of an individual.

In aging, regions like the hippocampus tend to shrink, and the lateral ventricles expand, signaling a decline in cognitive function. People with healthier brains often have a “younger” [brain age](#), while accelerated brain aging may indicate higher risks of cognitive issues.



HOC deviation change across diabetes status change following 18 mo of intervention. (CREDIT: The American Journal of Clinical Nutrition)© The Brighter Side of News

The DIRECT PLUS trial stands as one of the most comprehensive brain MRI studies to date, involving 300 participants divided into three dietary groups. Over 18 months, each participant underwent [whole-brain MRI scans](#), and their brain health was assessed using Hippocampal Occupancy (HOC) as a predictor of future dementia risk.

HOC, which decreases with age, served as a marker of how different diets impact brain aging. Using an advanced automated tool, NeuroQuant, the researchers analyzed the data and discovered notable improvements in participants who achieved better blood sugar control and followed specific dietary patterns.

The researchers linked reduced HbA1c levels, an indicator of blood sugar control, to positive changes in brain regions crucial for [cognitive and motor functions](#). Specifically, lower HbA1c was associated with healthier changes in the thalamus, caudate nucleus, and cerebellum. This connection emphasizes the importance of blood sugar management in protecting brain health over time.

Building on past research, the DIRECT PLUS trial examined the effects of the Green Mediterranean (Green-Med) diet, which has already been associated with benefits like improved blood sugar control. This diet, rich in plant-based polyphenols from sources like Mankai (a high-protein aquatic plant) and green tea, limits red and processed meats. These polyphenols, the study suggests, may

be especially beneficial as they cross the blood-brain barrier and reduce brain inflammation.

## Related Stories

[Vegan diet better than Mediterranean diet for weight loss, study shows](#) [Mediterranean diet significantly reduces the risk of death among American women](#) [Mediterranean lifestyle associated with a significantly lower risk of mortality](#)

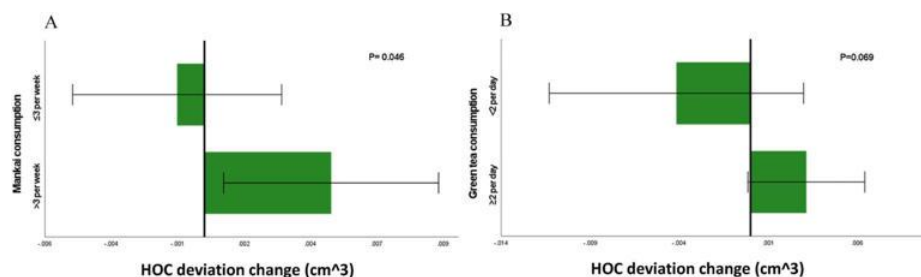
This is a promising finding because brain inflammation is a known contributor to cognitive decline. As Prof. Iris Shai from Ben-Gurion University explains, “Maintaining low [blood sugar levels](#), even within the normal range, shows promise for preserving a younger brain, especially when combined with a healthy diet and regular physical activity.” She adds that the polyphenols found in these diets play a key role in reducing inflammation in the brain, which is crucial for maintaining memory and cognitive function.

Dafna Pachter, a Ph.D. student who led the research, noted the potential of diet as a strategy to slow brain aging. “This trial offers a safe approach to potentially slow down our brain aging—by adopting the components of a green-Mediterranean diet,” she said.

The DIRECT PLUS trial adds significant weight to the idea that simple dietary changes could help reduce the risk of age-related cognitive decline. This is especially valuable as age-related [brain atrophy](#) can often precede conditions like dementia and Alzheimer’s disease.

While the exact causes of age-related atrophy vary, factors such as type 2 diabetes, hypertension, high cholesterol, and inflammation are known contributors. Individuals with diabetes, in particular, face a heightened risk of structural brain changes, including hippocampal shrinkage.





18-mo HOC deviation changes based on the specific Mankai plant and green tea; “green” dietary components. (CREDIT: The American Journal of Clinical Nutrition)© The Brighter Side of News

Past studies have shown that people with type 2 diabetes exhibit greater structural brain abnormalities, with a higher likelihood of accelerated brain aging. This includes shrinkage of the hippocampus, a critical area for memory, and the enlargement of the lateral ventricles, both of which signal a risk of [cognitive impairment](#). The Green-Med diet’s emphasis on blood sugar control and inflammation reduction may offer a pathway for slowing down these structural changes in the brain.

Funding for this study came from institutions including the [German Research Foundation](#), the Israeli Ministry of Health, the Israeli Ministry of Science and Technology, and the California Walnuts Commission. However, none of these organizations influenced the study’s design, execution, or analysis, nor did they have access to the results before publication.

The Green-Med diet’s impact on brain aging was particularly evident in participants who consumed high amounts of green tea and Mankai duckweed shakes. These participants not only saw improvements in blood sugar control but also exhibited less brain shrinkage over the study period. This connection suggests that the Green-Med diet could be instrumental in promoting both metabolic and brain health.

This study marks one of the first large-scale trials to link dietary changes directly to improved glycemic control and reduced brain aging. While more research is necessary to fully understand the mechanisms involved, these results offer a hopeful avenue for preventing age-related [cognitive decline](#) through dietary adjustments. For those seeking a way to support long-term brain health, the Green-Med diet could be a beneficial approach.

Through studies like DIRECT PLUS, the scientific community continues to uncover the profound impact that diet and lifestyle have on brain health. Aging may be inevitable, but research suggests that adopting healthy dietary habits can make a difference in maintaining brain vitality.

## **'Mind diet' could stave off thinking and memory problems, study finds**

**F**ollowing the Mind diet – which is rich in leafy vegetables, berries, nuts and beans – could stave off thinking and memory problems, according to new research.

Experts said it was “critical” to find changes that people could make to help prevent conditions such as dementia.

The Mind diet (known as the Mediterranean-Dash Diet Intervention for Neurodegenerative Delay) was created by experts including from the Harvard Chan School of Public Health in the US.

It recommends specific “brain healthy” foods that people should eat and also lists five unhealthy food items to limit.

The healthy items suggested by the diet include: three or more servings a day of whole grains, six or more servings a week of green leafy vegetables, one or more servings a day of other vegetables, five or more servings a week of nuts, four or more portions of beans, two or more servings a week of berries, two or more meals a week of poultry and one or more meals a week of fish.

Olive oil should be the main fat used in the diet while unhealthy items should be avoided or reduced.

This means there should be fewer than five servings a week of pastries and sweets, fewer than four servings a week of red meat, less than one serving a week of cheese and fried foods and less than one tablespoon a day of butter or margarine.

In the latest study, published online in the journal *Neurology*, experts looked at data for 14,145 people with an average age of 64, who were followed for a decade on average.

Some 70% of those in the study were white and 30% were black and all were asked to fill out questionnaires on their diet over the past year.

Researchers looked at how closely the foods people were eating matched the Mind diet.

People were given one point for each bit of adherence to the diet (such as if they had six or more weekly servings of green leafy vegetables or five or fewer weekly servings of pastries and sweets).

The total points possible was 12.

Experts then divided the people into three groups, with the low group having an average diet score of five, the middle group having an average score of seven and the high group having an average score of nine.

Thinking and memory skills were measured at the beginning and end of the study.

Cognitive impairment (when a person has trouble remembering, learning new things, concentrating, or making decisions that affect everyday life) developed in 532 people (or 12%) in the low diet group during the course of the study.

It also occurred in 617 people (or 11%) of people in the middle group, and in 402 people (or 10%) of people in the high group.

After adjusting for factors such as age, high blood pressure and diabetes, researchers found that people in the high group had a 4% lower risk of cognitive impairment compared to those in the low group.

Women were more likely to see benefit than men, though this needs further study, researchers said.

People who most closely followed the Mind diet also declined less rapidly than those who did not, with this link stronger among black people than white.

Study author Dr Russell Sawyer, from the University of Cincinnati in Ohio and member of the American Academy of Neurology, said: "With the number of people with dementia increasing with the aging population, it's critical to find changes that we can make to delay or slow down the development of cognitive problems.

"These findings warrant further study, especially to examine these varying impacts among men and women and black and white people, but it's exciting to consider that people could make some simple changes to their diet and potentially reduce or delay their risk of cognitive issues."

Previous research has suggested that the Mind diet can protect the brain by reducing oxidative stress and inflammation owing to its high levels of vitamins, carotenoids and flavonoids.

Experts say it may also reduce the risk of heart disease, diabetes and some cancers.

The study was funded by the National Institute of Neurological Disorders and Stroke and the National Institute on Aging.

Dr Jacqui Hanley, head of research at Alzheimer's Research UK, said: "There is a wealth of evidence that eating a healthy, balanced diet can help protect our brain health. But the benefits of specific diets is less clear.

"This study adds more evidence that a Mediterranean-style diet called the Mind diet – which includes leafy greens, nuts, poultry, fish, and berries – may delay cognitive decline, including memory issues.

"However, without a detailed picture of what's going on in the brain, we don't know whether there is a direct link between this diet and a reduced risk of cognitive impairment. Larger and longer-term studies will be needed to understand this effect more and this should be carried out in a more diverse group of people."

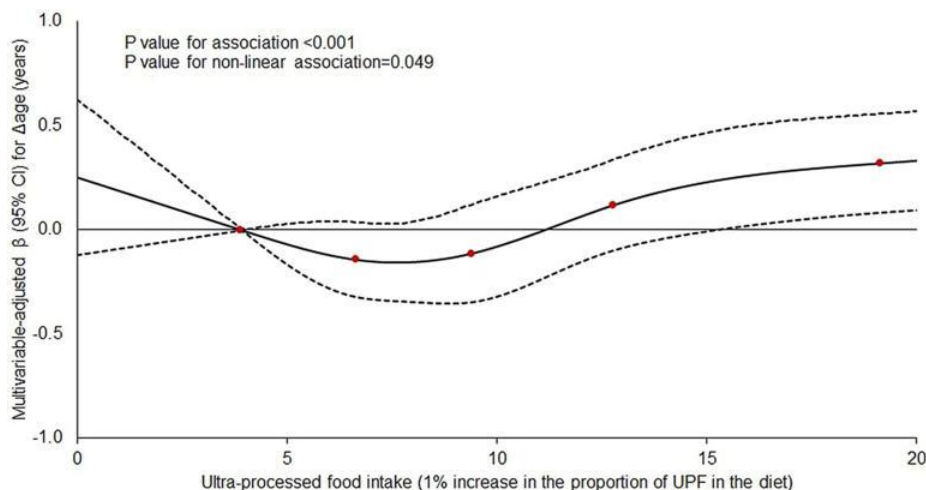
# Ultra-processed food consumption linked to accelerated aging

The world's aging population is reshaping healthcare and research priorities, emphasizing the need to explore aging's origins and mechanisms. While chronological age marks the passage of time, it doesn't fully reflect health status. [Biological age](#), which measures functional decline and physiological health, offers a more accurate gauge of aging.

Researchers have pinpointed various factors influencing biological aging, including inflammation, metabolism, and organ function. These insights pave the way for potential anti-aging interventions.

Biological age varies even among individuals of the same [chronological age](#), affecting susceptibility to diseases and mortality. Surprisingly, genetics account for only a small portion of this variability. Lifestyle and environmental factors, such as diet, play a much larger role.

Diets like the Mediterranean and DASH diets, known for their anti-inflammatory properties, have been linked to healthier aging markers, including longer telomeres and improved DNA methylation. Conversely, diets rich in processed foods and added sugars accelerate aging.



Multivariable dose-response association of biological aging with ultra-processed food consumption (1% increase in the proportion of ultra-processed food in the diet) in the Moli-sani Study cohort ( $n = 22,495$ ). (CREDIT: The American Journal of Clinical Nutrition)© The Brighter Side of News

## Beyond Nutritional Value: The Role of Food Processing

In recent years, researchers have challenged the traditional focus on a food's nutrient content, turning attention to how food processing affects health. The Nova classification system highlights the health risks associated with [ultra-processed foods](#) (UPFs).

These industrial products are engineered for palatability using calorie-dense ingredients and additives, often at the expense of nutritional quality. UPFs are high in sugars, salt, and unhealthy fats, but their health impact extends beyond poor nutrition.

### Related Stories

[Eating fewer ultra-processed foods greatly reduces Type 2 diabetes risk](#)  
[Ultraprocessed foods linked to cardiometabolic problems in children](#)  
[Eating ultra-processed foods leads to diabetes, heart disease, early death and more](#)

Studies suggest a strong link between UPF consumption and biological aging. In elderly Spanish populations, high UPF intake was associated with shorter telomere length—a biological aging indicator. Similarly, other studies found that UPFs negatively affect cognitive performance and increase the risk of frailty, both markers of [unhealthy aging](#).

## Groundbreaking Findings from the Moli-sani Study

A pivotal study by the Research Unit of Epidemiology and Prevention at the IRCCS Neuromed in Italy, in collaboration with [LUM University](#), sheds new light on this issue.

Published in [The American Journal of Clinical Nutrition](#), the study analyzed over 22,000 participants from the Moli-sani Study, one of Europe's largest population cohorts. Using over 30 blood biomarkers, researchers assessed participants' biological age, which reflects the body's true health condition.

|                                                     | UPF consumption (fifths of) <sup>1</sup> |                        |                        |                        |                       |
|-----------------------------------------------------|------------------------------------------|------------------------|------------------------|------------------------|-----------------------|
|                                                     | Q1                                       | Q2                     | Q3                     | Q4                     | Q5                    |
|                                                     | Reference                                | -0.15 (-0.39, 0.09)    | -0.14 (-0.39, 0.11)    | 0.10 (-0.16, 0.35)     | 0.34 (0.08, 0.61)     |
| <b>UPF + Mediterranean diet score</b>               | Reference                                | -0.16 (-0.40, 0.08)    | -0.16 (-0.41, 0.09)    | 0.08 (-0.18, 0.34)     | 0.31 (0.04, 0.59)     |
| Proportion explained <sup>2</sup> (95% CI); P value | —                                        | NM                     | NM                     | 20.4 (0.4, 94.2); 0.16 | 9.1 (1.0, 50.9); 0.16 |
| <b>UPF + FSAm-NPS dietary index</b>                 | Reference                                | -0.14 (-0.38, 0.11)    | -0.12 (-0.37, 0.13)    | 0.13 (-0.13, 0.38)     | 0.38 (0.10, 0.65)     |
| Proportion explained <sup>2</sup> (95% CI); P value | —                                        | 10.7 (0.8, 64.1); 0.14 | 16.1 (1.0, 79.1); 0.14 | NM                     | NM                    |

Abbreviations: FSAm-NPS, modified Food Standards Agency Nutrient Profiling System; NM, not mediating.

Mediation analysis testing overall diet quality as an explanatory factor of the association between ultra-processed food (UPF; weight ratio) consumption and biological aging ( $\Delta$ age) in the Moli-sani Study cohort (n = 22,495). (CREDIT: The American Journal of Clinical Nutrition)© The Brighter Side of News

Through detailed food frequency questionnaires, participants' UPF consumption was measured. These foods include products not typically made with kitchen staples—such as hydrogenated fats, maltodextrins, and hydrolyzed proteins—and are laden with additives like preservatives, flavor enhancers, and sweeteners.

Surprisingly, even seemingly harmless items like mass-produced bread, fruit yogurt, and [breakfast cereals](#) fall under the UPF category.



The results were striking. High UPF consumption was linked to significantly accelerated biological aging, with participants biologically older than their chronological age. "Our data show that high consumption of ultra-processed foods not only harms health but could also accelerate aging itself," explains Simona Esposito, the study's lead author.

### Mechanisms of Harm: Beyond Nutritional Deficiency

Although UPFs are nutritionally inadequate, their risks extend beyond missing nutrients. Marialaura Bonaccio, a nutritional epidemiologist involved in the study, notes that intense industrial processing alters the food matrix, compromising [fiber and nutrient content](#).

These changes affect crucial physiological functions, such as glucose metabolism and gut microbiota composition. Additionally, UPF packaging often contains harmful substances, further endangering health.

The study's findings call for a reassessment of [dietary guidelines](#). "Some nutrient-dense packaged foods are still classified as ultra-processed," says Licia Iacoviello, director of the Research Unit. "This underscores the need for dietary recommendations that consider food processing levels, guiding people towards healthier choices."

### Implications for Public Health

The connection between UPFs and accelerated aging emphasizes the need for public awareness. While cutting calories or focusing on macronutrient balance is important, understanding the health risks of food processing offers a broader perspective. Reducing UPF intake could help slow [biological aging](#), enhancing life quality and reducing age-related disease risks.

In a rapidly aging world, dietary shifts could play a vital role in promoting healthier aging. Public health initiatives must adapt, prioritizing not only nutritional content but also the degree of food processing. Such efforts could significantly improve health outcomes across all age groups.

# Focus on Healthy Aging With These 6 Expert-Approved Vitamins and Minerals

Maintaining a [balanced diet](#) is essential as you age to support everything from your bone health to your [immune system](#). Older adults are at a [higher risk for low vitamin consumption](#) than younger people, according to a paper published in Clinical Interventions in Aging.

Most people can get the vitamins and minerals they need through their diet. However, your doctor may recommend supplements or [multivitamins](#), especially if you're on certain medications that deplete your body of a particular nutrient or you have any dietary restrictions that limit major food groups.

To help you figure out exactly which vitamins and minerals you should focus on consuming in the name of healthy aging, we spoke with experts for their recommendations.

## 1. Magnesium

Magnesium is a mineral that provides several key functions in the body. It keeps your muscles strong, regulates blood sugar levels and contributes to heart health. [Dr. Jacob Teitelbaum](#), a board-certified internist in integrative medicine, told us that "magnesium is critical for well over 300 reactions in the body." He said an unprocessed diet has about 600 mg of magnesium daily, but the average American diet has less than 250 mg of magnesium after processing. For reference, the daily recommended amount of magnesium is [400 to 420 mg per day for adult men](#) and 310 to 320 mg for women, but more is needed for those who are pregnant or breastfeeding.

Dr. Teitelbaum warned that the effects of low magnesium may include an [increased risk of metabolic syndrome](#). This can lead to heart attacks, strokes and dementia. You may

also feel exhausted or experience widespread muscle pain if you're not getting enough magnesium.

You can find magnesium in a wide range of ingredients. [Dr. Peter Brukner](#), a specialist sports and exercise physician, said you can find magnesium in nuts, seeds, whole grains and leafy green vegetables like spinach. In extra yummy news, you can also get magnesium from dark chocolate.

"Some older adults or those who take specific medicines (such as diuretics or drugs for acid reflux) may not receive enough magnesium from their diet and might need [a supplement](#)," he said. "However, too much magnesium can cause stomach issues, so be careful."

## 2. B vitamins



Laurie Ambrose/Getty Images

You also need a range of B Vitamins, including B12 and folate (also called folic acid), to maintain your health as you age. Vitamin B-12 works with folate to help your body make new cells, including blood cells and nerve cells. While you don't usually require more

B12 as you age, your [body cannot absorb it as well](#) when you get older. Dr. Brukner said this is because "stomachs make less acid, and this acid is necessary to take the vitamin from food into the body."

Dr. Teitelbaum said B vitamins are critical for energy production, and suboptimal levels can affect your health. He warns that B vitamin deficiency has been associated with "a [marked increase of dementia](#) (especially folic acid) and [increased risk of heart attack and stroke](#) (especially in those with elevated homocysteine levels)." Symptoms of B12 deficiency include weakness or poor balance, loss of appetite and numbness and tingling in the hands and feet.

B12 is found in animal proteins like meat, fish and eggs. Dr. Brukner said that if you don't eat these foods, you may want to turn to foods like cereals and nutritional yeast with added B12.

"Older people, especially those having certain stomach issues or taking medicine that lowers stomach acid, might need to take a B12 vitamin supplement," he explained. [Amelia Ti](#), a registered dietitian and diabetes educator in NYC, who is also part of CNET's medical review board, adds that people taking medicine that blocks B12 absorption, like omeprazole or metformin, may also need a vitamin B12 supplement.

### 3. Calcium

The National Institute on Aging says that calcium is especially important for [older people at risk for bone loss](#). The Institute recommends 1,000 mg each day for men between the ages of 51 and 70, and 1,200 mg per day for men 71 and older. [Women aged 51 and up](#) are recommended to take 1,200 mg each day.

"Calcium is well-known for making bones strong, but it is also crucial for muscles to work right," Dr. Brukner said. "As people become older, their bodies take in less calcium from food, which can cause bones to become weaker." You can get calcium naturally from sources like milk, yogurt and cheese. The Harvard T.H. Chan School of Public Health notes that [calcium is also available](#) in kale, salmon, tofu, almonds and spinach.

As for supplements, Dr. Brukner said, "If you are at risk for bone troubles or don't get enough calcium in your food, taking supplements might be useful. But too much calcium can cause other issues like kidney stones, so talk with your doctor first."

## 4. Vitamin D



Malorny/Getty Images

Vitamin D is often called the sunshine vitamin because you typically absorb it through the skin just by being outside. However, during winter months, if you live in a cloudy climate or avoid natural sunlight as you age, you may not get enough. Your body [needs vitamin D to properly absorb calcium](#), making it an important nutrient for bone health.

Dr. Brukner says that in addition to sunshine, you can get vitamin D from fatty fish like salmon and mackerel, fortified milk and cereals. Your doctor may also recommend a supplement if you're experiencing bone loss or at risk of osteoporosis.

In addition to bone health, Dr. Teitelbaum said vitamin D can help you fight off disease. He said, "Suboptimal vitamin D is associated with [increased autoimmunity](#), higher risk of severe infectious diseases ([Dr. Fauci noted that he took vitamin D](#) during the COVID [pandemic]) and [increased cancer risk](#)."

## 5. Omega-3 fatty acids

Omega-3 fatty acids are essential to many of your body's functions. They play a role in both heart and [brain health](#). However, as Cleveland Clinic points out, your body [isn't able to produce enough omega-3s on its own](#). This means you need to get more from [the foods you eat](#) or supplements you take.

"Omega-3 fatty acids are very good for heart health and can help lessen swelling, which is important for older people," Dr. Brukner explained. "They are also beneficial for brain well-being and might help guard against memory loss and [diseases such as Alzheimer's](#)." Ti adds that omega-3s help lessen swelling by reducing inflammation.

Fatty fish like salmon are a good source of omega-3 fatty acids. Dr. Brukner said you can also turn to flaxseeds, chia seeds and walnuts but added a warning: "These give a different type of omega-3 that the body does not use so easily."

Fish oil and algae oil can serve as supplements, too.

## 6. Zinc

A [2015 paper](#), published in Pathobiology of Aging and Age-related Diseases, calls zinc an "essential micronutrient for human health in general, and particularly for the elderly." The authors say zinc plays "an important role in the aging process" and that zinc deficiency may be connected to several age-related chronic illnesses, which include hardening of the arteries, degenerative diseases of the nervous system, age-related changes to the immune system and cancer.

"When we get older, our immune system becomes weaker, and if we don't have enough zinc, this can make it even worse," Dr. Brukner explained.

You can find zinc in shellfish, red meat, poultry, beans, nuts and seeds. Dr. Brukner said oysters are particularly zinc-rich. He added, "Some older people might find zinc supplements helpful, especially if they often get sick or do not eat enough foods high in

zinc. But taking too much zinc can cause problems with other minerals in the body, so it's important to follow advised amounts."

## The bottom line

Eating well can help boost your bones, immune system and more as you age. [Along with exercise](#) and other good habits, getting the right minerals and vitamins may improve your health. Try to get ample magnesium, B vitamins, calcium, vitamin D, omega-3s and zinc in your diet each day. Make sure you talk to your doctor before you take any supplements to find out how they may interact with your existing medications and health conditions.

## Lab-made muscle: New laser tech grows real human tissues to replace lab rats

Think of a future where injuries heal faster, diseases are cured more effectively, and lab-grown meat is a reality. This future is one step closer, thanks to the innovative work of Dr. Hao Liu from ETH Zurich.

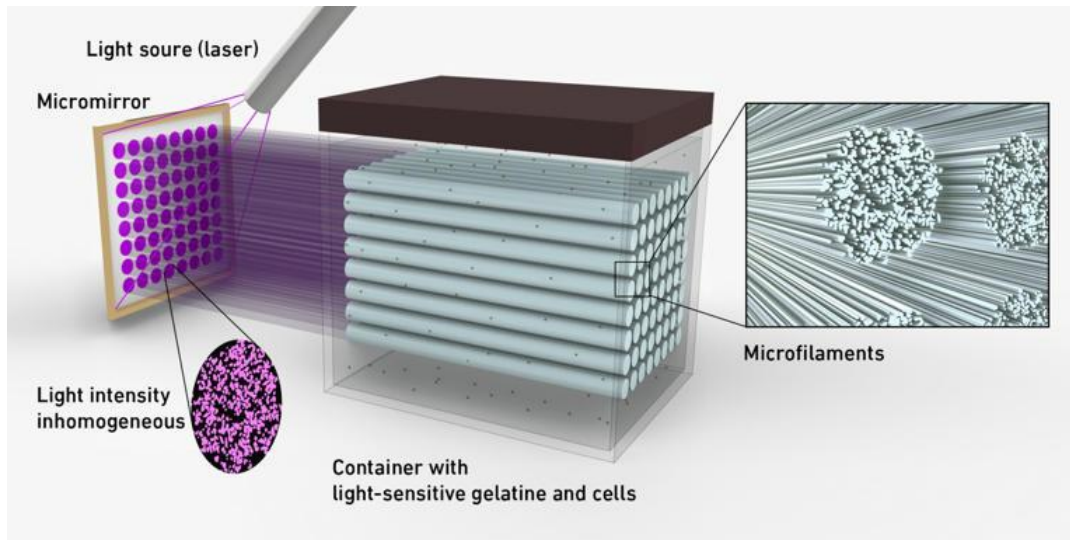
Liu uses laser technology to create intricate, microscopic structures that mimic the natural architecture of human tissues.

These structures, made from a special type of gelatin, serve as scaffolds for growing cells. By carefully controlling the laser, Liu and his team can create highly aligned microfilaments (protein filaments). The filaments replicate the precise structure found in tissues like muscles, tendons, and nerves.

For this, the researchers have created a compact bioprinter to develop biological tissues with microfilament structures. He is now working to bring this technology to market.

"Our aim is to create human tissue models for high-throughput drug screening and other applications," Liu said.





The microfilaments are created because laser light is inhomogeneous. (Visualisations: Liu H et al. Advanced Materials 2022, CC-BY 4.0)

## Creating biological tissues

The human body is composed of various tissues, each with specific structures and functions. These tissues, like muscles, tendons, connective tissue, and nervous tissue, exhibit organized cellular arrangements. This organization is crucial for their proper functioning.

To replicate natural tissue structures in the lab, researchers create 3D scaffolds using bioprinters. These scaffolds serve as a template for growing cells, resulting in perfectly structured tissue.

Engineered tissues can be used for various purposes, including surgical replacements, medical research, and food production. Interestingly, they can repair damaged nerves, model diseases for drug testing, and produce lab-grown meat.

In this work, Liu first printed tissue scaffolds and then used a novel method to create highly aligned, fine filaments.

He utilized a light-sensitive gelatin, which transitions from liquid to solid when exposed to laser light.

“Where we expose it with a laser, it solidifies into hydrogel. Wherever the laser can’t reach, the gelatine remains liquid,” Liu said.

He successfully created microfilaments within the hydrogel, comparable in size to the fibrous components found in natural tissues. Subsequently, he cultivated cells on this scaffold to generate aligned tissue structures.

## Laser beam phenomenon

The filamented light (FLight) 3D bioprinter utilizes a unique optical phenomenon to create highly aligned microfilament structures within a hydrogel matrix.

Laser beams exhibit uneven light intensity, with areas of high and low energy.

When a light-sensitive material is exposed to such a beam, it solidifies unevenly, forming parallel, thread-like structures with channel-like spaces between them.

These structures, with diameters ranging from 2 to 20 micrometers, mimic the natural arrangement of many body tissues. When cells are introduced into these scaffolds, they grow along the channels, resulting in aligned [tissue](#) constructs.

“The optical phenomenon that creates the filament microstructures in the gel has long been known to physicists and material scientists. But it hadn’t yet been used in biology; we’re the first,” Liu said.

Utilizing this printing method, the team has produced tissue constructs similar to [muscle](#), tendon, nerve, and cartilage tissues. ETH Zurich has patented this technology

## They CRISPR’ed tomatoes to make them sweet and large

Today's [mass-produced tomatoes](#) often grow to palm-sized proportions, but their naturally occurring ancestors were far smaller fruits. They were also sweeter and more flavorful due to their lower water content compared to the red fruits found in grocery stores—but recent genetic discoveries have unlocked the path to attaining the best of both worlds. Using [CRISPR editing techniques](#), researchers created new “mutant” tomatoes that are as large as modern varieties while retaining a sweeter, more enjoyable taste. And all it took was deactivating two genes.

A team led by geneticists at the Chinese Academy of Agricultural Sciences in Beijing utilized the CRISPR-Cas9 technique to identify the pair of genes controlling sugar amounts in the tomato species, *Solanum lycopersicum*—the calcium-dependent protein, kinase 27 (SLCDPK27 or SICPK27) and its paralogue, SLCDPK26. These, according to researchers, act as a tomato's “sugar brakes” by degrading the enzymes responsible for sucrose production. By simply deactivating the two genes, the new varietal grew fruit with 30 percent more glucose and fructose than common mass-production tomatoes. What's more, doing so resulted in no measurable change in fruit size or total quantity.

“Although there are fewer, lighter seeds in the mutants, they exhibit normal germination,” the team wrote in their study published on November 13th in [Nature](#). “Together, these findings provide insight into the regulatory mechanisms controlling fruit sugar accumulation in [tomatoes] and offer opportunities to increase sugar content in large-fruited cultivars without sacrificing size and yield.”

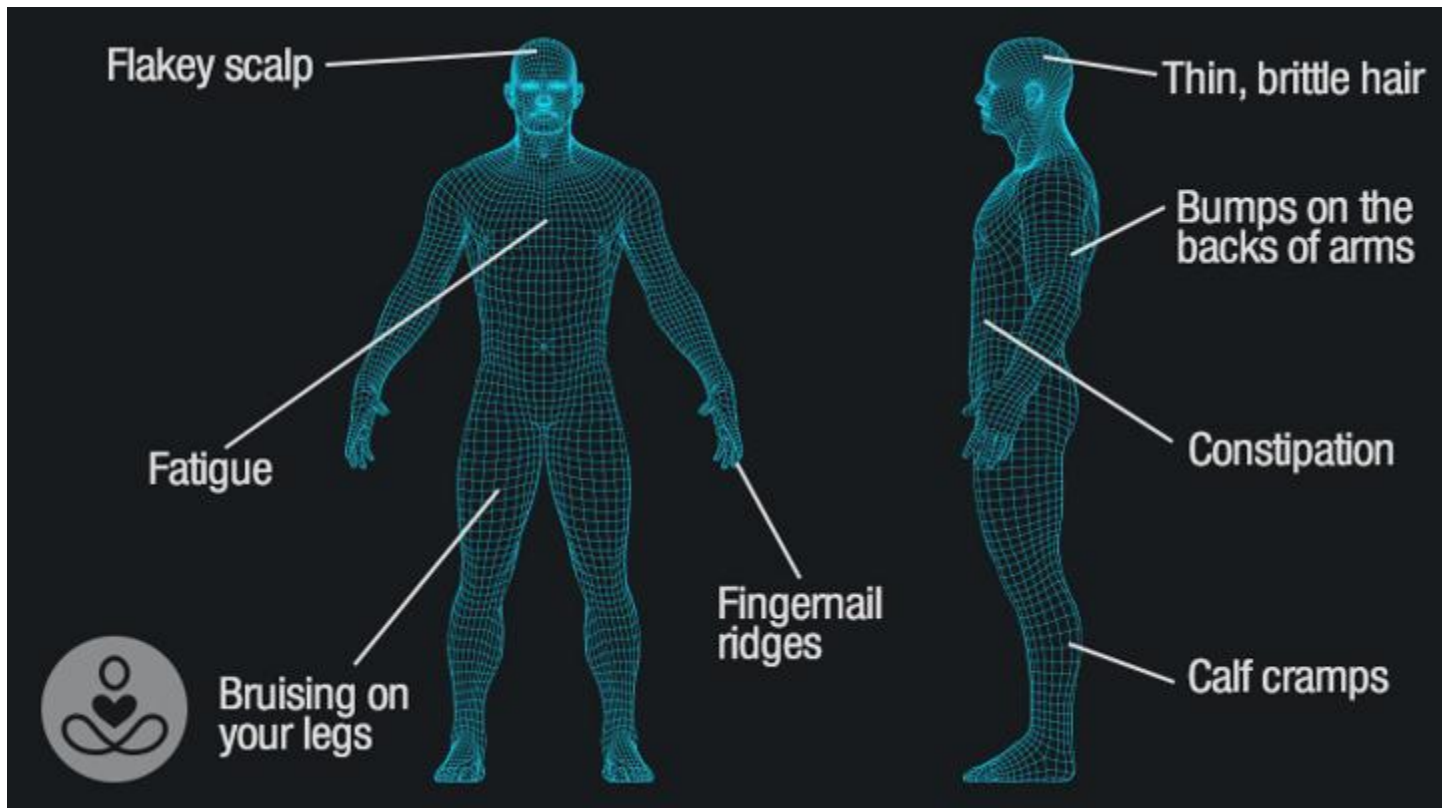
According to study co-author Jinzhe Zhang, the new mutant tomatoes are a marked improvement on those found in supermarkets.

“[They] taste like water. They're flavorless,” Zhang complained of today's options in an [accompanying profile](#).

But it's not just the flavor improvement that's important. *Nature* notes that an estimated 205 million tons of tomatoes are produced globally each year, most of which are as much as 100 times bigger than their wild ancestors. All that extra water requires removal for products like tomato paste, however, resulting in extra

energy, financial, and time costs. Sweeter tomatoes may one day offer more efficient produce options for manufacturers. And because the two isolated genes are found in many other plant species, similar genetic editing may help improve other agricultural staples in the future

## 10 Signs Of A Vitamin Deficiency And What To Do About It



10 Signs Of A Vitamin Deficiency And What To Do About It© Provided by The Hearty Soul

When it comes to our health, it's often easy to get lost or overwhelmed by everything we see online, on TV, in the news, and even from our own friends and family. Something that should be straightforward quickly becomes confusing and convoluted. Add the layer that everyone's bodies are different and have different needs, and yeah, it can seem a bit impossible. That being said, if you know what to watch for, the body can "communicate" to you what it needs. The following

are some common signs of [vitamin deficiency](#) to watch out for and what you can do to meet your nutritional needs.

Read: [3 Vitamin Deficiencies Linked to Headaches](#)

## The most common signs of vitamin deficiency (and foods to help)



Credit: Shutterstock© Provided by The Hearty Soul

Eating healthy is pretty simple. In Michael Pollan's book *In Defense of Food*, he lays it out quite clearly: *Eat real food. Mostly plants. Not too much.* What does he mean? Well, real food is not pre-prepared foods that come from a box or foods filled with various processed ingredients. Make sure that most of the foods you eat are plant and plant-based: more fruits and vegetables, more beans and legumes, that sort of thing. Finally, don't overeat. Even a [healthy diet](#) can become less so if consumed in excess.



While we should all strive to follow that method of eating, sometimes, life gets in the way. Sometimes, our bodies don't absorb certain nutrients like other bodies do. Or, perhaps we've just fallen into unhealthy habits and need to improve. Regardless of the reason, if you are deficient in a nutrient, your body will send you signs.

## 1) Bumpy skin

Often red or white, bumps on your skin (e.g., buttocks, thighs, arms, and cheeks) can signal something called keratosis pilaris — a skin condition that usually disappears in adulthood. Though its cause isn't completely understood, research suggests that an abundance of keratin is being produced in hair follicles, which causes the bumps. There are individuals with keratosis pilaris as a result of genetics. But, as outlined in *The National Academies of Sciences, Engineering, and Medicine*, studies show that people exhibiting the signs of keratosis pilaris may be lacking enough vitamin A and vitamin C in their diets. ([1](#),[2](#))

### **Foods to add to your diet:**



Credit: Shutterstock© Provided by The Hearty Soul

- Dairy
- Eggs
- Fish

- Dark leafy greens (contains provitamin A/beta carotene)
- Organ meats
- Yellow-orange vegetables (contains provitamin A/beta carotene)
- Citrus fruits (lemons, limes, oranges)
- Acerola cherries
- Guavas
- Kale
- Broccoli Kiwis

## 2) Brittle nails and weak hair

The causes of these symptoms are plenty, but biotin or vitamin B7 deficiency is an especially well-researched reason. People who smoke or drink heavily, are pregnant, or have digestive disorders are at risk of developing a vitamin B7 deficiency. (3) You can also eat things that can trigger this deficiency. For example, raw [egg](#) whites contain avidin, a protein that binds to and reduces its absorption of vitamin B7. Consuming raw egg whites can lead to this deficiency.

[\(4,5\)](#)

**Foods to add to your diet:**





Credit: Shutterstock© Provided by The Hearty Soul

- Organ meats
- Fish
- Meat
- Dairy
- Egg yolks
- Spinach
- Nuts
- Seeds
- Broccoli
- Sweet potatoes
- Whole grains
- Bananas
- Cauliflower

### 3) Restless leg syndrome (RLS)

Also called Willis-Ekbom disease, [restless leg syndrome](#) is a nervous system disorder that causes symptoms such as general sensory discomfort, burning or itching in the lower body, and an uncontrollable urge to move. RLS affects up to 10% of Americans, and women are twice as likely to experience it, according to the National Institute of Neurological Disorders and Stroke. The most common deficiency linked to RLS is iron deficiency. Many studies have evidence suggesting that low blood iron can make the symptoms of restless leg syndrome worse. [\(6,7\)](#) Iron levels can drop drastically during pregnancy, so this is often found in pregnant women. [\(8\)](#)

### **Foods to add to your diet:**

- Meat
- Poultry
- Fish
- Dark leafy greens
- Nuts
- Seeds
- Whole grains

## **4) Bleeding gums**

Chances are, once you start flossing regularly enough, your gums will stop bleeding. However, a vitamin C deficiency can also be at the root of bleeding gums. The body cannot produce vitamin C by itself. Without sufficient levels of vitamin C in your body, the body is missing out on its antioxidant, immune-boosting, and wound-healing properties. While eating just a few pieces of fruit and vegetables daily should reach your vitamin C goals, you can always increase your status. As a water-soluble vitamin, there is no fear of overconsuming it, particularly through food sources. [\(9,10\)](#)

## **Foods to add to your diet:**



Credit: Shutterstock© Provided by The Hearty Soul

- Blackcurrants
- Citrus fruits (e.g., oranges, limes, and grapefruit)
- Berries
- Kiwi
- Tomatoes
- Broccoli
- Sprouts

## 5) Dandruff and flaky skin

The skin disorder called seborrheic dermatitis (SD) affects the areas of your body that produce oil. Generally, people with SD experience dandruff and flaking skin (e.g., on the face, groin, armpits, and chest) shortly after birth, during puberty, and mid-adulthood. It's so common, in fact, that 50% of adults and 42% of infants will likely experience seborrheic dermatitis at some point in their lives. (11) Though not fully understood, studies have linked SD to mineral deficiencies, including zinc, vitamin B2 (riboflavin), vitamin B3 (niacin), and vitamin B6

### Foods to add to your diet:



- ## 6) Mouth ulcers

187

iron levels as those without. (14) Another study found a correlation between vitamin B1, B2, and B6 deficiencies and mouth ulcers in 28% of patients. (15)

### **Foods to add to your diet:**



Credit: Shutterstock© Provided by The Hearty Soul

- Poultry
- Meat
- Fish
- Legumes
- Dark leafy greens
- Nuts
- Seeds
- Whole grains
- Green vegetables
- Starchy vegetables
- Dairy

## **7) Constipation**



When you're backed up and haven't had more than three [bowel movements](#) in a week, your body's trying to tell you something. More often than not, though, there's a relatively quick and natural fix. According to the U.S. Department of Agriculture, adults consume approximately *half* of the recommended daily fiber intake for men (38 grams) and women (25 grams). (16) A meta-analysis has showed that dietary fiber intake can definitely increase stool frequency in patients with constipation. (17) Another study showed evidence that increasing magnesium intake can help people with constipation. (18)

### **Foods to add to your diet:**



Credit: Shutterstock© Provided by The Hearty Soul

- Flaxseeds
- Broccoli
- Apples
- Lentils
- Figs
- Prunes
- Spinach

## **8) Leg bruising**

Have you ever looked down to see your leg bruised, with no idea of how it got there? You may be bruising a bit too easily. According to medical professionals, you may lack vitamin C, which is crucial in making [collagen](#). This, in turn, helps the formation of blood vessels. A vitamin C deficiency can cause your body's capillaries to weaken and increase your chances of bruising. ([19](#))

### **Foods to add to your diet:**



Credit: Shutterstock© Provided by The Hearty Soul

- Citrus fruits
- Strawberries
- Broccoli
- Brussels sprouts
- Cauliflower
- Green and red peppers
- Spinach
- Cabbage
- Mango



## 9) Fatigue

If you feel tired all the time, regardless of how much sleep you get, you could suffer from a vitamin D deficiency. Symptoms of a vitamin deficiency may include depression, hair loss, muscle pain, bone and back pain, and tiredness. In a double-blind randomized placebo-controlled trial, however, researchers found that vitamin D helped treat fatigue among otherwise healthy individuals. ([20](#))

### **Foods to add to your diet:**



Credit: Shutterstock© Provided by The Hearty Soul

- Fatty fish (e.g., tuna, mackerel, salmon)
- Fortified soy and almond milk
- Cheese
- Egg yolks
- Mushrooms

## 10) Calf cramps

Calf and other muscle pain can often be traced back to [insufficient magnesium levels](#). This "miracle mineral" is involved in over 600 cellular reactions, including

muscle contractions. However, almost 70% of American adults are magnesium deficient. (21) Magnesium helps muscles relax by acting as a natural calcium blocker since calcium binds to specific proteins to cause muscles to contract. (22) Without enough magnesium to compete against calcium, your calf muscles among others may over-contract, which causes cramps. (23)

### **Foods to add to your diet:**



Credit: Shutterstock© Provided by The Hearty Soul

- Pumpkin seeds
- Spinach
- Swiss chard
- Black beans
- Flaxseeds
- Almonds
- Cashews
- Dark chocolate
- Avocado
- Tofu

- Salmon

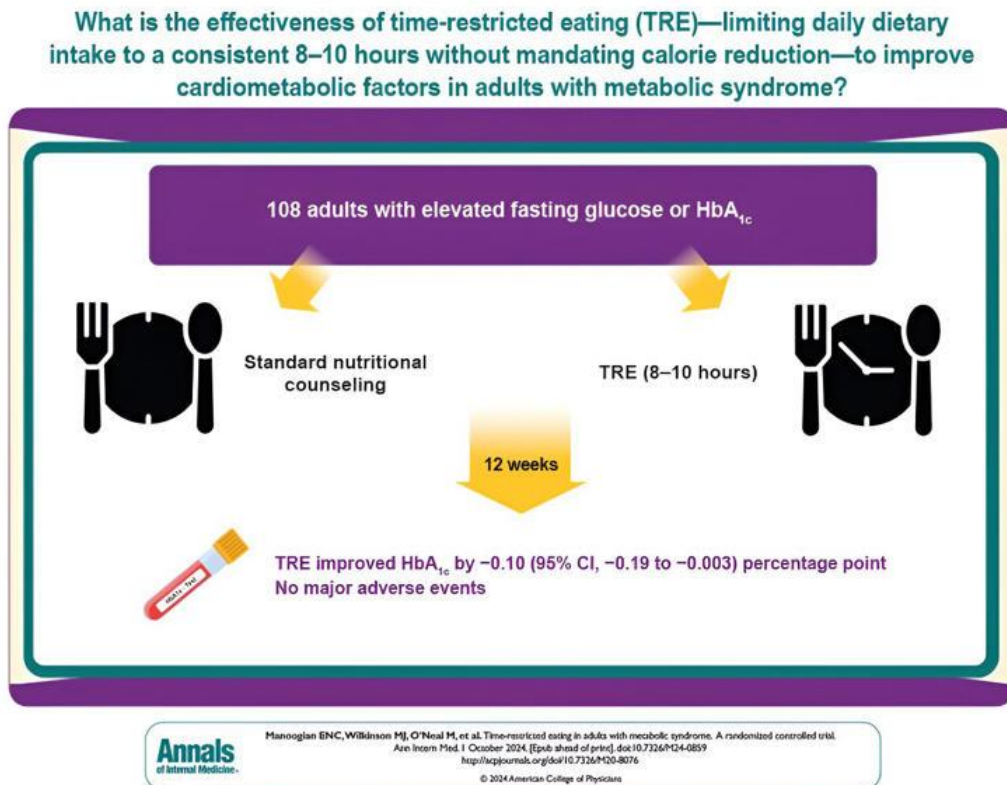
## **Notice any of the signs above in your own body?**

If you notice these signs in your body, the first thing to do is to clean up your diet and see how your body responds. In the meantime, you can see your healthcare provider, who may also make some suggestions for you. The important thing is that you don't only turn to conventional medicine to solve the problem. If you do without changing your diet and lifestyle habits, the problem will only return.

In combination with daily physical activity and an overall healthy lifestyle, you can start adding these healthy, whole foods to your diet. Supplements, too, have their time and place and can work to help fortify your diet. Talk to your healthcare practitioner before you start taking any new supplements to see if they're right for you.

*Disclaimer: This information is not intended to be a substitute for professional medical advice, diagnosis or treatment and is for information only. Always seek the advice of your physician or another qualified health provider with any questions about your medical condition and/or current medication. Do not disregard professional medical advice or delay seeking advice or treatment because of something you have read here.*

# One in three Americans has a dysfunctional metabolism: Clinical trial suggests intermittent fasting could help



Time-restricted eating in adults with metabolic syndrome. Credit: Annals of Internal Medicine (2024). DOI: 10.7326/M24-0859

More than one-third of adults in the United States have metabolic syndrome, a cluster of conditions that significantly raise a person's risk of heart disease, stroke, and type 2 diabetes. These conditions include high blood pressure, elevated blood sugar, excess abdominal fat, and abnormal cholesterol levels.

In a new clinical trial, researchers at the Salk Institute and University of California San Diego School of Medicine found that time-restricted eating—also known as

intermittent fasting—could offer significant health benefits to adults with metabolic syndrome.

Patients who ate within a consistent eight-to-ten-hour window each day for three months saw improvements in several markers of blood sugar regulation and metabolic function compared to those who received standard treatments.

"Our bodies actually process sugars and fats very differently depending on the time of day," says Salk Professor Satchidananda Panda, co-corresponding author of the study and holder of the Rita and Richard Atkinson Chair. "In time-restricted eating, we are re-engaging the body's natural wisdom and harnessing its daily rhythms to restore metabolism and improve health."

The TIMET study is the first to evaluate the benefits of a customized time-restricted eating schedule in patients taking medication for metabolic syndrome. The results are published in [\*Annals of Internal Medicine\*](#).

"For many patients, metabolic syndrome is the tipping point that leads to serious and chronic diseases like diabetes and heart disease," says co-corresponding author Pam Taub, professor of medicine at the UC San Diego School of Medicine and a cardiologist at UC San Diego Health.

"There is an urgent need for more effective lifestyle interventions that are accessible, affordable, and sustainable for the average American."

Western diets high in sugar, salt, and fat, combined with increasingly sedentary lifestyles, are thought to have contributed to the rising rates of metabolic dysfunction. While the initial recommendation may be to "eat less and move more," these lifestyle changes are difficult for most people to sustain long-term. The researchers say time-restricted eating offers a more practical approach accessible to a wider range of patients, including those already on medication.

"Unlike expensive pharmaceuticals like Ozempic, which require lifetime use, time-restricted eating is a simple lifestyle change that doesn't cause side effects and can be maintained indefinitely," says first author Emily Manoogian, a staff scientist in Panda's lab at Salk. "Patients appreciate that they don't have to change 'what' they eat, just 'when' they eat."

In the new study, time-restricted eating protocols were customized to each participant's eating habits, sleep/wake schedules, and personal commitments. The resulting regimen had them reduce their eating window to a consistent eight to ten hours per day, beginning at least one hour after waking up and ending at least three hours before going to sleep.

Manoogian says this personalized approach made the intervention easier for patients to complete, compared to other intermittent fasting studies, which typically assign the same strict time window to all participants.

The TIMET study also accepted participants who were on medication for metabolic syndrome—a group usually excluded from such trials. This makes it the first study to measure the benefits of time-restricted eating in addition to existing standard-of-care pharmacological treatments.

In the study, 108 adults with metabolic syndrome were randomly sorted into either the time-restricted eating group or the control group. Both groups continued to receive standard-of-care treatments and underwent nutritional counseling on the Mediterranean diet. Participants also logged their meals using the "myCircadianClock" mobile app, developed at Salk.

After three months, patients who had completed the time-restricted eating regimen showed improvements in key markers of cardiometabolic health, including blood sugar and cholesterol. They also saw lower levels of hemoglobin A1c, a marker of long-term blood sugar control. This reduction was similar in scale to what is typically achieved through more intensive interventions by the National Diabetes Prevention Program.

The time-restricted eating group also showed 3–4% greater decreases in body weight, body mass index (BMI), and abdominal trunk fat, a type of fat closely linked to metabolic disease. Importantly, these participants did not experience significant loss of lean muscle mass, which is often a concern with weight loss.

The TIMET trial adds to a growing body of evidence supporting the use of time-restricted eating as a practical, low-cost intervention to improve cardiometabolic health.

The promising results suggest that health care providers could consider recommending the lifestyle intervention to patients with metabolic syndrome as

a complement to existing treatments, though additional long-term studies are needed to determine whether time-restricted eating can sustain these benefits and ultimately reduce the risk of chronic disease.

**More information:** Emily N.C. Manoogian et al, Time-Restricted Eating in Adults With Metabolic Syndrome, *Annals of Internal Medicine* (2024). [DOI: 10.7326/M24-0859](https://doi.org/10.7326/M24-0859)

Provided by Salk Institute

## 'Mind diet' could stave off thinking and memory problems, study finds

Following the Mind diet – which is rich in leafy vegetables, berries, nuts and beans – could stave off thinking and memory problems, according to new research.

Experts said it was “critical” to find changes that people could make to help prevent conditions such as dementia.

The Mind diet (known as the Mediterranean-Dash Diet Intervention for Neurodegenerative Delay) was created by experts including from the Harvard Chan School of Public Health in the US.

It recommends specific “brain healthy” foods that people should eat and also lists five unhealthy food items to limit.

The healthy items suggested by the diet include: three or more servings a day of whole grains, six or more servings a week of green leafy vegetables, one or more servings a day of other vegetables, five or more servings a week of nuts, four or more portions of beans, two or more servings a week of berries, two or more meals a week of poultry and one or more meals a week of fish.

Olive oil should be the main fat used in the diet while unhealthy items should be avoided or reduced.



This means there should be fewer than five servings a week of pastries and sweets, fewer than four servings a week of red meat, less than one serving a week of cheese and fried foods and less than one tablespoon a day of butter or margarine.

In the latest study, published online in the journal *Neurology*, experts looked at data for 14,145 people with an average age of 64, who were followed for a decade on average.

Some 70% of those in the study were white and 30% were black and all were asked to fill out questionnaires on their diet over the past year.

Researchers looked at how closely the foods people were eating matched the Mind diet.

People were given one point for each bit of adherence to the diet (such as if they had six or more weekly servings of green leafy vegetables or five or fewer weekly servings of pastries and sweets).

The total points possible was 12.

Experts then divided the people into three groups, with the low group having an average diet score of five, the middle group having an average score of seven and the high group having an average score of nine.

Thinking and memory skills were measured at the beginning and end of the study.

Cognitive impairment (when a person has trouble remembering, learning new things, concentrating, or making decisions that affect everyday life) developed in 532 people (or 12%) in the low diet group during the course of the study.

It also occurred in 617 people (or 11%) of people in the middle group, and in 402 people (or 10%) of people in the high group.

After adjusting for factors such as age, high blood pressure and diabetes, researchers found that people in the high group had a 4% lower risk of cognitive impairment compared to those in the low group.

Women were more likely to see benefit than men, though this needs further study, researchers said.

People who most closely followed the Mind diet also declined less rapidly than those who did not, with this link stronger among black people than white.

Study author Dr Russell Sawyer, from the University of Cincinnati in Ohio and member of the American Academy of Neurology, said: "With the number of people with dementia increasing with the aging population, it's critical to find changes that we can make to delay or slow down the development of cognitive problems.

"These findings warrant further study, especially to examine these varying impacts among men and women and black and white people, but it's exciting to consider that people could make some simple changes to their diet and potentially reduce or delay their risk of cognitive issues."

Previous research has suggested that the Mind diet can protect the brain by reducing oxidative stress and inflammation owing to its high levels of vitamins, carotenoids and flavonoids.

Experts say it may also reduce the risk of heart disease, diabetes and some cancers.

The study was funded by the National Institute of Neurological Disorders and Stroke and the National Institute on Aging.

Dr Jacqui Hanley, head of research at Alzheimer's Research UK, said: "There is a wealth of evidence that eating a healthy, balanced diet can help protect our brain health. But the benefits of specific diets is less clear.

"This study adds more evidence that a Mediterranean-style diet called the Mind diet – which includes leafy greens, nuts, poultry, fish, and berries – may delay cognitive decline, including memory issues.

"However, without a detailed picture of what's going on in the brain, we don't know whether there is a direct link between this diet and a reduced risk of cognitive impairment. Larger and longer-term studies will be needed to understand this effect more and this should be carried out in a more diverse group of people."

# What Is the MIND Diet? A Mediterranean Diet Offshoot Aimed at Giving You a Sharper Brain

The human brain contains an estimated 86 billion neurons that comprise [100 trillion connections](#). These connections and the chemical signals sent through them are the reason you're able to put one foot in front of the other, take a deep breath, and remember the daily tasks you need to accomplish. As you age, these neurons begin to shrink, and their function naturally decreases. However, research shows that you can slow down or reduce this cognitive decline by [loading your plate](#) with certain "neuroprotective foods" and limiting how much and how often you consume foods that are known to cause inflammation in the body.

The most popular—and most studied—framework for eating to support brain health is a variation of the [Mediterranean diet](#) known as the [MIND diet](#) (short for the Mediterranean-DASH Diet Intervention for Neurodegenerative Delay), which was introduced by researchers from Rush University and the Harvard Chan School of Public Health in 2015.

"[Lead researcher [Martha Clare Morris](#)] took a look at Mediterranean diet studies that were already showing reduced dementia risk and cardiovascular risk reduction across the board and said: 'Okay, the Mediterranean diet's good for the heart. We've got some data that shows it's good for the brain. What if you take the Mediterranean diet and you make it more brain specific?'" explains physician and chef [Annie Fenn, MD](#), founder of Brain Health Kitchen, who has studied the effects food has on Alzheimer's disease for nearly a decade.

The result, which Dr. Fenn has built off of in her own work, is an eating plan that includes nine "brain-healthy" food groups and five types of foods to limit or avoid. "I try to make it really simple for people: eat more of this, less of that," Dr. Fenn says. "Because with the brain-healthy diet, in terms of actually reducing outcomes, reducing dementia later, very small changes in diet for most people have huge benefits later."

# Foods to Eat for a Healthier Brain

According to psychiatrist [Drew Ramsey, MD](#), author of [Eat to Beat Depression and Anxiety](#), eating for a healthier brain means eating more whole, real foods. He says prioritizing home-cooked meals and nutrient-dense foods over ultra-processed food products not only aids brain function but also benefits mental health.

“The new science of mental health is much more about, how do we increase brain growth and repair and decrease inflammation?” says Dr. Ramsey. “Food is involved in all of these processes.”

So, what’s on the menu for a healthier brain—and mind? Dr. Fenn breaks down the food groups currently recommended by the MIND diet:

**Whole grains:** According to Dr. Fenn, [whole grains](#) (like oatmeal, quinoa, or brown rice) reduce cholesterol and stabilize blood sugar, both of which play important roles in reducing metabolic diseases associated with Alzheimer’s.

**Vegetables:** Veggies are rich in [flavonoids](#), which are known to suppress inflammation in the brain.

**Leafy greens:** Leafy greens get their very own category in the MIND diet, says Dr. Fenn, with research showing that as little as a single serving a day can [reduce cognitive decline](#).

**Nuts and seeds:** Nuts and seeds are rich in antioxidants, chemical compounds known to quell the inflammation and oxidative stress that can lead to neurodegenerative disease. Dr. Ramsey adds that many seeds—including pumpkin, hemp, and sesame—are also high in zinc. “Zinc is involved in 300 biochemical reactions in the brain, and lower levels of zinc are correlated with higher levels of depression,” he says.

**Beans and legumes:** A diet staple of people who live in [Blue Zones](#), or regions of the world with the longest average lifespans, beans and legumes improve metabolic health and reduce cholesterol, says Dr. Fenn.

**Berries:** “Berries are recognized as the only [fruit that's proven to be neuroprotective](#),” says Dr. Fenn. Scientists believe this is because they’re high in antioxidants.

**Poultry:** The MIND diet recommends a limited amount of animal-based protein: approximately two meals a week. Poultry (as well as beans, legumes, and many seafood) is also high in vitamins B9 (folate) and B12. "It's known that deficiencies in these B vitamins cause depression, dementia, and anxiety," says Dr. Ramsey.

**Fish and seafood:** According to Dr. Ramsey, fish and other forms of seafood are rich in long-chain omega-3 fatty acids. He recommends wild salmon, rainbow trout, mussels, sardines, and anchovies as great sources of this brain-healthy nutrient.

**Olive oil:** This Mediterranean diet fave is a great source of vitamin E, which Dr. Ramsey says is brain-protective, and polyphenols, a type of antioxidant. "Researchers started to give really young, really nutrient-dense olive oil to people who already have early dementia, and they have found that it actually improves symptoms, and it might be that polyphenol content," says Dr. Fenn.

## Foods to Avoid for Better Brain Health

Let's get this out of the way: You're not going to be happy with this list. According to the MIND diet, you should limit your intake of pastries and sweets, red meat, cheese, fried foods, and butter.

"So this entire discussion of brain-healthy eating is about including the foods that we know are neuroprotective—like the leafy greens, the vegetables, and the berries—but also excluding the foods that we know drive up our cholesterol, specifically our LDL cholesterol," says Dr. Fenn. All five food groups that the MIND diet recommends limiting are high in saturated fat, which is known to increase LDL cholesterol.

"These foods are also bad for metabolic health, and that's a huge factor in [Alzheimer's disease](#)," says Dr. Fenn. People with diabetes, for instance, have at least double the risk of Alzheimer's later in life, she says. "So [when you're cutting out sugary drinks](#), processed food, nutrient-poor foods that tend to feed into obesity, diabetes, insulin resistance, all these metabolic problems, then you are also reducing Alzheimer's risk at the end of the day."

Research also increasingly supports cutting back on or completely eliminating your alcohol intake. The version of the MIND diet, which was first published in 2015, included red wine as the tenth most brain-healthy food, but newer research has caused medical professionals to reverse the course here. "There's an accumulation of data showing that [there's probably no minimum dose](#) of alcohol that is beneficial to brain health long-term," says Dr. Fenn.

"As a psychiatrist, I think alcohol is bad for your mental health," adds Dr. Ramsey. "We're increasingly understanding that the science of alcohol has really been wrong. Five years ago, three years ago, we would've had that soundbite: two drinks for a man, one drink for a woman, red wine's great for health. All that science has been turned on its head. There's [no amount of alcohol consumption that is beneficial for health.](#)"

## Eating Habits for a Healthier Brain

"This is never just a discussion about nutrition; it's always about lifestyle," says Dr. Fenn. The key to the MIND diet, Mediterranean diet, and also Blue Zones-style eating is slowing down and savoring the food you're putting in your mouth. "[These lifestyles include] enjoying food with family and friends, sitting down at a table to eat, walking after dinner—simple things like that that are huge contributors to the health of those populations," she says.

Dr. Ramsey agrees that "finding your food roots," as he calls it, is an important part of using food to support your mental health. "I like omega fats and brain growth and all this stuff, but...my favorite way that food helps mental health is the way that it connects us," he says. "It connects us to the soil, it connects us to each other, it connects us to this really rich culinary history, this kind of shared experience."

Finally, Dr. Fenn notes that while the MIND diet is the most studied form of brain-healthy eating, it's surely not the only way to go about staving off cognitive decline through food. "The reality is a brain-healthy diet is a very mindful look at mixing animal- and plant-based products. But that's going to be different for everybody, and it can depend on where you're from," she says. "You don't have to be eating like Mediterranean people. If you grew up in a Latin-American

household, an African-American household, an Asian-American household, there are heritage diets from other cultures that are probably just as brain-healthy as Mediterranean-style ones."

So, in her eyes, the MIND diet is a useful starting point, not gospel. "Adapt it to what you like to cook, what you like to eat, what your food heritage is," she says. "These are the things that make a diet sustainable."

## Foods that slow brain aging and how to incorporate them in your diet

A new study has shown that specific nutrients, similar to those found in the Mediterranean diet, can play a crucial role in slowing brain aging, according to Healthline.

### **Foods that slow brain aging**

Scientists have found that fatty fish should be included in your diet.

"**Fatty fish**, like salmon, mackerel, sardines, and trout, are rich in omega-3 fatty acids, and we should aim to have at least one portion of oily fish a week," the researchers say.

**Leafy greens** like spinach, kale, and broccoli are also excellent choices. They provide carotenoids, such as lutein and zeaxanthin.

**Nuts and seeds** are another product worth stocking up on. Almonds, sunflower seeds, and flaxseeds contain vitamin E and ALA (alpha-linolenic acid).

To add more choline to your diet, try including **eggs and liver**. Filling your plate with **colorful vegetables** and fruits is also a good idea. Peppers, tomatoes, and oranges are rich in antioxidants and vitamin C.

### **How to incorporate more brain-healthy foods into your diet**



You don't need to completely overhaul your diet to prioritize your brain's health. You can start with small steps in the right direction.

Dietitian Ludlam-Raine advises choosing one or two days a week to include **salmon, sardines, or mackerel in your meals.**

You can also increase your intake of **leafy greens** by adding spinach or kale to smoothies, salads, and side dishes.

For snacks, Ludlam-Raine recommends keeping **almonds, sunflower seeds, and flaxseeds** on hand.

You can eat them alone or add them to yogurt, cereal, or porridge for a more complete meal.

Breakfast is a great time to increase your choline intake by having **eggs**. Finally, Ludlam-Raine advises adding plenty of color to your plate with an array of fresh **fruits and vegetables.**

Aim for a variety of colorful foods to ensure a good mix of antioxidants and carotenoids.

The key is to consume whole, minimally processed foods as much as possible.

"Try to eat at least five portions of fruits and vegetables a day and 30 different plant-based foods a week. Eat the rainbow to obtain all the nutrients you need," advises the expert.

# Eating fish or meat could protect your brain as you age



Fatty fish like salmon are great for brain health. Enn Li Photography/Getty Images© Enn Li Photography/Getty Images

- Plant-based diets are popular for longevity, and there's good science backing the strategy.
- But a new study suggests being 100% vegetarian may not be best for aging brains.
- A doctor suggests consuming some fatty fish like salmon or sardines roughly twice a week.

In Loma Linda, California, there's a group of [Seventh-Day Adventists who tend to live and thrive](#) for up to 10 extra years beyond their fellow Americans. Not all of them [make it to 100](#), but they do tend to enjoy relatively good health for longer than most people in the US. That's why it's known as a "[Blue Zone](#)."

A big part of the winning Adventist strategy seems to be the food. Adventists prioritize plants in their diet like [beans, vegetables, and whole grains](#), and generally don't eat a ton of meat or junk food.

But a new study of more than 88,000 of Adventists across North America adds a caveat. The new research suggests that while vegetarian diets are generally good for a person's overall health, they may not be the best deal for an aging brain.

"Even though the vegetarian diet is doing a lot of good things, once it delivers people up into their 80s, it looks like some improvement is possible," Gary Fraser, an Adventist cardiologist and public health researcher who lives in Loma Linda, told Business Insider. "It may not be the meat of course, but it just could be."

Fraser's new [study](#) showed that vegetarian Adventists living into their 80s and beyond suffered slightly higher rates of strokes, dementia, and Parkinson's disease than other Adventists who ate some meat.

He has developed a two-part weekly plan for his own brain health based on his own research. It includes one daily supplement and one repeat menu item.

## **Being vegetarian is good for you in your early**

Vegetarian and vegan diets — especially bean- and whole grain-forward ones — are great at lowering the risks of life-threatening illnesses.

"We are kind of used to the vegetarians doing well at everything," Fraser said.

"We have very good evidence that, generally speaking, vegetarian diets are very good at preventing a substantial number of what we might call 'premature deaths' in the 50s, 60s, maybe early 70s."

Even in old age, a good [anti-inflammatory](#) vegetarian diet can lower the odds of renal failure, infectious disease, type 2 diabetes, or heart disease, Fraser's latest study found.

So eating ultra-processed red meat or poultry every single day isn't a longevity solution. [Research suggests](#) that for most of us, the reverse is true: swapping a few portions of bacon here and there or regular hot dogs for some beans and whole grains would boost our cognitive health.

Fraser suspects that what's going on with the aging brain and meat consumption data may come down, at least in part, to an absorption issue. As we age, our

body becomes less efficient at turning essential nutrients like omega-3 fatty acids from nuts or oil that we consume into the brain food we need to thrive.

"The lack of the long chain omega-3s in the very elderly may be part of the problem," he hypothesized.

This doesn't mean that the average meat-eater's diet is a boon for brain health. Fraser's team only studied Adventists, people who (generally speaking) have a healthier, more nutrient-dense diet than most people.

Overall, it's still hard to argue with the existing body of evidence suggesting that leaning into more vegetarian items including [leafy greens](#), lots of colorful vegetables, and a generous dollop of olive oil, is all [great for brain health](#), and certainly better than what researchers refer to as the SAD "standard American diet," which is high in ultra-processed cakes, snacks, and sugary beverages, but [low in nutrition](#).

## **This doctor's winning weekly routine includes fish and one supplement — the same pill longevity fiends love**

Lots of longevity doctors take Vitamin D. Science Photo Library/Getty Images© Science Photo Library/Getty Images

At home in California, Fraser, a practicing Adventist in his late 70s, follows a fairly straightforward weekly routine. It doesn't tend to include much of any red meat [or milk](#), but there are two core components he points to that are aimed at preserving brain health.

First, there is the fish. Fraser recommends aiming for around two meals a week that include some kind of fatty fish, with plenty of omega-3s in it. His personal favorite?

"Salmon is the one I like the best," he said. But sardines, herring, anchovies, and trout are also [nice choices](#).

Salmon is a great source of omega-3 fatty acids, which are essential for keeping our brains healthy. Previous research has already suggested there are strong connections between omega-3 consumption and better cognition. One [2022 study](#) found that middle-aged adults who consume omega-3s regularly tend to have better abstract reasoning and that the areas of their brain responsible for learning and memory are physically bigger.

Fatty fish, meat, and eggs are also rich in the nutrient choline. Choline keeps our cells healthy, and helps with memory, mood, and overall brain function. While there is a [good dose](#) of it in soybeans and potatoes, it tends to be most abundant in meatier items like chicken, beef, eggs, and fish.

"Choline is another very important chemical in brain tissues," he said. "And again, vegetarians don't get much of that."

In addition to the regular fish portions, Fraser also takes a whopping 4000-5000 IUs of vitamin D per day — more than five times the daily [recommended](#) dose for his age group (800 IU). Many other longevity physicians and public health experts, including Dr. Anthony Fauci, also say they [pop big doses of vitamin D](#). Fraser says he feels comfortable with such a colossal dose because he knows that our ability to absorb vitamin D from the sun wanes with age. Plus, in addition to being good for bone health, there is [some evidence](#) that vitamin D is good for preserving brain function.

But Fraser says generally speaking, people under 70 don't need to worry so much about all this. As we age, the way the body works and absorbs nutrients changes.

It's still not totally clear why, but Fraser says: "by the time you reach the age of let's say 75 or so, you'd be wise to add some fish until we know better."

## **The most anti-inflammatory foods you can eat to improve energy, mood, and sleep**

**Y**ou may already know that [stress eating](#)—mindlessly downing

unhealthy [snacks](#) when you're feeling overwhelmed and emotionally spent— isn't great for long-term health. Often these feel-good foods make us anything but:

Science shows that fried, fatty, sugary, [ultra-processed](#) foods [increase inflammation](#) in the body.

## What is inflammation?

Inflammation is our immune system's response to stimulus, such as an injury or infection. In small doses, it's actually good for you—it increases blood flow and sends the right immune system cells to the affected area, kicking your body's defenses into action.

But low-grade inflammation that continues over time—like the kind caused by constant [stress](#)—not only raises your risk for chronic disease, it also creates more psychological distress, essentially worsening the feelings that make us stress-eat in the first place.

While many of the [processed](#), sugar-heavy foods Americans tend to turn to for comfort fall firmly into the pro-inflammatory camp, there are other foods that can actually dial inflammation down in the body. Anti-inflammatory foods are those that are rich in plant compounds such as polyphenols as well as natural antioxidants, which help reduce oxidative damage to your tissues. Some of the foods that make the cut include fruits, vegetables, whole grains, beans, fish, poultry, nuts, seeds, and olive oil.

This raises the question: If you're living with chronic stress, could you turn to an anti-inflammatory diet for relief? Dr. Uma Naidoo, a Harvard-trained nutritional psychiatrist and author of [This Is Your Brain on Food](#), says the answer is yes—with a few caveats.

"In life, in medicine, in health, it's never just one thing," she says. "A holistic approach to stress involves a little bit of mindfulness and [exercise](#), as well as better eating. But if you're only able to choose one thing to focus on, pick diet, absolutely. Food can make a difference."

Stress management through food can work, but it's not a quick fix. You're playing the long game. "It's a marathon, not a sprint," says Naidoo. "You're creating one of the foundational pillars of health, and that takes slow and steady lifestyle changes."

## An anti-inflammatory diet

Simply cutting inflammatory foods from your diet will boost your [energy](#), mood, and [sleep](#), but Naidoo says consistent anti-inflammatory eating will change the makeup of your digestive system in about a month. "A lot of us walk around with inflammation in the gut that's related to the food we eat, and healing of the gut takes about 28 days," she says.

As a rule, your goal should be fewer processed foods and more whole foods. A shift in this direction will have lasting benefits, not just for your physical health but your mental health too.

## Grow good gut bacteria

A [2020 study in the journal Gut](#) showed that a Mediterranean diet, where fish, poultry, fruits, vegetables, whole grains, and healthy fats rule, reduces inflammation in the body by changing your gut biome, or the types of bacteria that live in your digestive system. [Probiotic](#), [fermented foods](#) can also get your gut headed in the right direction.

**Best foods:** Greek yogurt, kefir, kimchi, kombucha, sauerkraut

## Reduce cortisol levels

[Cortisol](#) is a hormone produced during your body's stress response. Your adrenal gland releases it when you're in a stressful situation and helps manage your "fight or flight" reaction. Just like stress, you need it in small doses. Foods rich in magnesium can help your body metabolize cortisol so it doesn't hang around for too long in your body. [Magnesium](#) can even help you get some fast-acting relief from stress by promoting relaxation.

**Best foods:** Avocados, bananas, broccoli, dark chocolate, pumpkin seeds, spinach

## Regulate stress hormones

Don't overlook herbs and [spices](#). Some of your favorite pantry staples are high in anti-inflammatory power. "Garlic is a prebiotic that helps balance your gut by



stimulating healthy bacteria growth," says Naidoo. "And turmeric impacts the hippocampus, which is a part of the brain that helps regulate stress hormones."

**Best foods:** Garlic, turmeric, ginger, cinnamon, cayenne

## Fight free radicals

[Phytonutrients](#) are compounds that give plants their rich colors. Most fruits and veggies are full of them. When you fill your plate with deep reds, oranges, yellows, blues, and greens, you're loading up on inflammation protection. There's no end to the hues you can use to squash stress.

**Best foods:** Leafy greens, blueberries, strawberries, carrots, sweet potatoes, blackberries, beets

## 5 anti-inflammatory snacks that boost energy and focus during your workday

More Americans reported snacking as a result of the COVID-19 pandemic, and 26% reported snacking multiple times a day with 38% replacing meals with snacks according to 2020 data from the [Food & Health Survey from the International Food Information Council](#). If you get hangry like me, it's beneficial to have an idea of what snacks may help you get through the workday.

Nutritionists point to the types of snacks that may help boost energy and productivity versus perpetuate that [midday slump](#). Sustained energy throughout the day is best met with snacks rich in protein, fiber, and healthy fats, says Dr. Linda Anegawa, an internal and obesity medicine physician and medical director at [PlushCare](#), which offers primary care and mental health services.

"Proteins and fats provide more slow-release energy than other types of foods, which helps avoid sugar crashes that can diminish energy," she says.

Carbohydrates alone are digested faster and may promote quick bursts of energy but not sustained energy, says Angela Blackstone, a registered dietitian at the Ohio State University Wexner Medical Center. She recommends pairing carbohydrates with foods rich in fiber and protein and avoiding [ultra-processed](#),

sugary, pro-inflammatory foods that contribute to an increased risk for chronic diseases. Think of snacking as ways to incorporate more nutrients and antioxidant-rich whole foods into your day.

Even having snacks on hand in preparation for a busy workday can be beneficial.

“Be mindful when snacking. Plan and prepare snacks in advance by having foods cut, washed, and portioned out,” says Blackstone.

And monitor your “hunger cues” that say it’s snack time. They may surface in the form of fatigue, low energy, or irritability, says Jenna Amos, a registered dietitian and nutrition manager at Freshly, a meal delivery service. Here are five snacks that can help boost energy midday:

## **Greekyogurt**

A cup of greek yogurt is high in protein and low in sugar, packed with calcium, probiotics, and vitamin B12. This snack can help give you more sustained energy throughout the day. It may also improve bone health—which can be extra beneficial for those working from a desk all day, Anegawa says.

## **Mixed nuts**

Nuts are an easy go-to snack that can help with “sustained energy,” Anegawa says, adding that they are rich in protein and “heart healthy fats.”

“If you enjoy a sweet and salty flavor combo, add in a tablespoon of stevia-sweetened dark chocolate chips,” she says.

## **Hard-boiled eggs**

Hard-boiled eggs are packed with protein and antioxidants and are good to have on hand.

“Add a cheese stick in for extra satisfaction,” Anegawa says. “If saturated fat is something you are aiming to reduce, go for a part-skim version.”

## Raw vegetables and hummus

Raw vegetables have fiber and antioxidants like vitamins A, K, and folate, which can help you feel full and maintain energy. Consider a side of hummus with one cup of carrots, cucumbers, and bell peppers, Blackstone says.

## Chickpeas

Chickpeas are another easy-access snack that contain high levels of fiber and protein. Consider roasting them with a few spices to add flavor (I personally roast chickpeas with paprika, cumin, and some cayenne).

Eating every three to four hours to curb hunger pains is normal, Blackstone says, so don't beat yourself up for grabbing a snack to make it through the workday. It's about knowing which foods can provide that sense of satisfaction and fullness that are also going to help you sustain energy.

"Snacking looks different for every person, every day. More active days may require more snacks, while a more sedentary day may require fewer or no snacks," Amos says. "Snacks should be viewed as a mini-meal fuel source to hold ourselves over until a more substantial meal later in the day."

## It's not 8 glasses a day anymore. Here's how much water you should drink each day

**If you're drinking eight eight-ounce cups of water a day you're doing well, but you could likely benefit from some adjustments.**

DANIEL GRILL VIA GETTY IMAGES

With brand-name [water bottle](#) fads and gallon-a-day [water challenges](#) trending on TikTok, [hydration](#) is in, and that's good news for health. The average human body is more than 60% water. Water makes up almost two-thirds of your brain and heart, 83% of your lungs, 64% of your skin, and even 31% of your bones. It's involved in almost every process that keeps you alive. So if you've hopped on the water-drinking bandwagon, you're doing yourself a big solid.

“Water is essential for your body’s survival,” says [Crystal Scott](#), registered dietitian-nutritionist with Top Nutrition Coaching. “It helps regulate your temperature, transports nutrients, removes waste, lubricates your joints and tissues, and it also plays a crucial role in maintaining the delicate balance of electrolytes and fluids in your body.”

You lose water when you breathe, sweat, urinate, and metabolize food and drink into [energy](#). If you don’t replace that fluid, your health can go downhill, and fast. Without food, your body can keep ticking for as long as three weeks or more. But without water, you’ll die in only a few days. There’s just too many systems that depend on it.

“I like to correlate our bodies with planet earth,” says Scott. “Our earth is made up of a large percentage of water. If that amount got too low, what would happen to our food systems? Our forests? Animal life? It’s a domino effect.”

To keep that first domino from falling, she says, drink up.

“It’s the starter when looking at any form of change or issues with your nutrition or your lifestyle—assess water intake first and foremost,” says Scott. “It helps with fullness cues, it can improve cognitive function, mood, physical performance, and can prevent health problems like constipation, kidney stones, and urinary tract infections. It’s one of the foundational building blocks.”

Bottom line: Water is life. But how much should you be downing daily not just to survive, but thrive?

## **How many ounces of water should I drink a day?**

The common rule of thumb you’ve likely heard is the 8×8 rule: Drink eight eight-ounce cups of water a day. If you’re achieving that, you’re doing well, says Scott. But it’s possible you could benefit from some adjustments.

“I don’t think that amount is necessarily wrong, but I think research over time has definitely evolved,” she says. “Water recommendations are going to vary depending on age, sex, and activity level.”

Your intake recommendation may vary based on life circumstances too. For example, if you live in a hot and humid climate, get a lot of [physical activity](#), are pregnant, or are breastfeeding, you may need more water daily than the average adult. Your doctor can help guide you.

The National Academies of Science, Engineering, and Medicine recommends an average daily water intake of about 125 ounces for men and about 91 ounces for women. If you’re not filling up a [water bottle](#) to exactly that amount every day, you’re probably still close or even over, because you also get water from food, says Scott.

“You can get a lot of hydration from foods like celery, oranges, strawberries, watermelon, and cucumbers,” she says. “All are hydrating foods that can actually help supplement your water intake.”

## **How much water is too much?**

Although it’s rare, it is possible to [drink too much water](#). It’s a condition called hyponatremia, and it happens when the amount of water in your system overwhelms your kidneys and they can’t keep up with a normal filtration rate. The sodium content of your blood becomes dangerously diluted and causes your cells to swell. Certain health conditions such as kidney failure and congestive heart failure put you at higher risk of it, and some high-level athletes may experience it if they don’t replace their [electrolytes](#) after exercising.

## **How do I know if I’m drinking enough water?**

For the majority of the population, the bigger issue is getting enough water. While it’s helpful to keep tabs on actual ounces, the best indicator

of whether you're well hydrated is your body. When you don't get enough water, your body will show certain signs.

"Urine color is a really great indicator of hydration status," says Scott. If your toilet water is pale yellow or clear after you pee, you're golden. Dark yellow or amber colored urine are signs your body needs fluids.

[Headaches](#), migraines, bad sleep, constipation, dizziness, and feeling lightheaded or confused can also be symptoms of dehydration. When in doubt, head to the spout.

## **Tips for getting your daily fill**

If you're committing yourself to hydration optimization, Scott recommends starting slow. First take stock of where you are, and then set a goal for where you want to be.

"Half your body weight in ounces is a great starting point," she says. "So for someone who's 200 pounds, our first goal would be 100 ounces. And let's say they're only drinking 20 ounces of fluid a day. So every week, we'd want to increase about eight to 10 ounces a week, slow and steady. Because if you do hydrate too quickly, people can feel really waterlogged."

Other handy tips Scott suggests:

- Experiment with drinking it ice-cold or adding sliced fruit to give it flavor.
- Use smaller water bottles and refill them instead of filling a huge jug for the whole day, which can feel daunting to conquer.
- Split your day into increments and give yourself a mini goal in each section. That way you're keeping a steady stream of hydration going instead of trying to gulp it all in one go.

# The 5 best supplements for healthy aging, according to a longevity expert

If you've ever walked down the supplement aisle in a pharmacy, you've seen the overwhelming abundance of options available for your medicine cabinet.

According to the 2022 Council on Responsible Nutrition Consumer Survey on Dietary Supplements, 75% of Americans use [dietary supplements](#), most on a regular basis.

It's important to remember that supplements are just that: supplemental. While they're good for giving you a bit of a leg up when you're lacking certain nutrients, the number one way to get the vitamins and minerals and antioxidants you need is through a healthy, nutritious diet.

"Supplements will never give you what actual, real food will," says Kara Burnstine, RD, a nutrition educator at [Pritikin Longevity Center](#). "They simply aid you along. They're not meant to be a food replacement."

Still, Burnstine recognizes there can be setbacks of relying solely on food for optimal nutrition, and there are times when supplements can be a boon.

"It would be wonderful if we all ate all our fruits and vegetables and our whole grains and our lean proteins and got everything that we needed from the food supply, but unfortunately, our food supply is sometimes not the highest quality either," she says. "So we could be doing a lot of the good things and not be getting all of the nutrients from the food."

That deficit can become even more pronounced as you age, she says.

"We are machines, so as we get older, things that worked well start to not work as well. That's when we might need to turn more to supplements."



Not all supplements are for everyone. You should always consult your doctor before starting any supplement to be sure they won't interact with medications you're taking or put you at risk of other problems. But for most people approaching or in their golden years, here's what Burnstine recommends:

## **Calcium for bone strength**

Calcium does a lot for you: It plays an important role in blood clotting, it helps your muscles contract, and it regulates normal heart rhythms and nerve functions. It also builds and maintains strong bones. When you don't take in enough calcium, your body borrows it from your bones to keep things running smoothly. A daily intake of calcium helps you replace this calcium and [keep bones healthy](#).

When you reach age 50, your daily calcium requirement goes up. Prior to that, 1,200 milligrams a day will do you, but when you hit the half-century mark, it's time to bump up to 1,500 milligrams a day. Women who are past menopause are at the highest risk of getting [osteoporosis](#), a disease that makes bones weak and brittle. [Lack of calcium](#) ups these chances even more.

Burnstine says if you know you're not getting at bare minimum two servings from a calcium source each day, a calcium supplement is a good idea. But the supplement is only one piece of the puzzle.

"In addition to the calcium supplement, I'm also going to recommend that you get at least two servings of dairy or that you eat a lot of green leafy vegetables, and you do resistance training, which protects bones more than anything else," she says.

## **Vitamin D for immunity (and bone strength)**

Speaking of healthy bones, your body can only absorb calcium when [vitamin D is present](#). In addition, [vitamin D](#) has anti-inflammatory, antioxidant, and neuroprotective properties. It supports immune health, muscle function, and [brain cell activity](#).

Your body doesn't make vitamin D, so you have to get it from outside sources. These include food, the sun, or vitamin D supplements. Before age 70, your daily requirement is 600 IU. After 70, it goes up to [800 IU](#). In your later years, your body may need a boost to meet these goals.

“As we age, most of us no longer absorb vitamin D as well,” says Burnstine. This can be especially true if you live in an area without much sun, or if you're always wearing sunscreen.

## Probiotics for gut health

Emerging studies suggest that supplements of [probiotics](#)—the “good” bacteria that live in your digestive system and helps keep “bad” bacteria in check—may help counteract age-related shifts in gut microbiota, improving your immune health and aiding [healthy digestion](#) as you age.

“We know that if our gut health is good, everything else follows, in terms of [inflammation](#), [brain fog](#), weight loss, [sleep](#), depression,” says Burnstine. “Our gut is tied to just about everything.”

As with most nutrients, it's best to get probiotics through the foods you eat. You can load up on them through fermented foods such as yogurt, kefir, kombucha, refrigerated sauerkraut, kimchi, tempeh, and miso. But a probiotic supplement isn't a bad idea.

Some supplements have upwards of 50 billion CFUs (colony-forming units), which may seem like a huge amount, but Burnstine says your body absorbs only 20% to 30% of that.

“Taking a supplement helps create that diversity and huge population of probiotics in the gut to help us be healthy, lose weight, and lower our cholesterol,” she says.

## **Magnesium for mood**

Magnesium is attached to immune function, enzymatic reactions, and it plays a part in lowering inflammation. It's also a key player in mood stabilization. Magnesium levels go down as age goes up, putting you at risk of mental health struggles.

“People who are low in magnesium tend to have higher depression,” says Burnstine. Chronically low levels can also increase your chances of having high blood pressure, heart disease, Type 2 diabetes, and osteoporosis.

Anyone over age 30 should be getting 320 to 420 milligrams a day, but Burnstine says not all magnesium supplements are the same.

“For example, you could take a magnesium carbonate, but you could also take something called magnesium glycinate, which is slightly easier on the stomach,” she says. “The combination of how it's formulated causes sort of different responses.” Talk to your doctor about the best magnesium formulation for you.

## **Multivitamin to cover the bases**

A daily multivitamin, while not a panacea, can give you an overall nutritive boost. At the very least, says Burnstine, it won't hurt.

“I always say that a multivitamin is sort of like an insurance policy,” she says. “I would recommend a general multivitamin at any age.”

## **Ultra-processed foods can undermine your health. Here's how to identify and avoid them**

In an age where [convenience](#) often trumps nutritional value, a [growing body of research](#) is raising concerns about the health implications of eating [ultra-processed foods](#). These foods undergo extensive industrial

processing, resulting in products that are convenient, hyper-palatable, and potentially detrimental to long-term health.

While processing itself is not inherently negative, (think pasteurized milk or extra virgin olive oil) the extent of processing and its impact on nutrient density are critical factors to consider. Ultra-processed foods, which are commonly defined under a classification known as [NOVA](#), contain additives and undergo significant alterations from their natural state. They tend to be energy-dense, nutrient-poor, and often have long shelf lives.

It's raising concerns about their role in diet-related health outcomes such as [heart disease](#), [diabetes](#), and [obesity](#), as our busy lifestyles may push us to reach for easy, quick, or low-cost, rather than cooking and eating more unprocessed or minimally processed foods like fruits, vegetables, eggs, nuts or seeds.

“As dietitians, we prefer to talk about the actual foods and nutrients and teach people how to read labels and what to look for, rather than focus on a broad, sweeping category,” says Caroline Passerello, a registered dietitian nutritionist and spokesperson for the Academy of Nutrition and Dietetics.

Often, a particular food may not be a clear cut yes or no. “It requires education and label reading and knowing what to look for and what not to look for,” she adds.

Consider the level of food processing, the overall nutrient density of foods and your overall dietary patterns, Passarrello suggested. Packaged cookies and sodas are energy dense but lack the [nutrients](#) our bodies need. While they may provide some energy and calories, they're not supplying vitamins or minerals. This may lead to nutrient deficiencies over time, as well as unintended weight gain, according to Passerello, who is also an instructor at the University of Pittsburgh.

However, there's a spectrum. "The way our bodies respond to the calories and nutrients varies, depending on our age, activity level, and overall dietary patterns," she says.

While [the NOVA classification system](#) provides the most common framework for understanding the continuum of food processing, several other classification systems, including one from the [International Food Information Council](#), or IFIC, use slightly different criteria to define ultra-processed and processed foods. Generally, however, [these guidelines agree](#) that highly processed foods contain high amounts of total and added sugars, fats, and/or salt, low amounts of [dietary fiber](#), use industrial ingredients, whether derived from foods or created in labs, and typically contain little to no whole foods.

It's easy to find these highly processed foods on supermarket shelves:

- mass-produced bread
- carbonated drinks
- breakfast cereals
- ice cream

These are just some products which typically contain artificial colors, flavors, and preservatives. These goods are designed for prolonged shelf life, convenience, and profitability, often at the expense of nutritional value.

## **How an ultra-processed diet affects your health**

Research has shown a clear association between consumption of ultra-processed foods and adverse health effects. A recent study in [the British Medical Journal](#) highlights a link between ultra-processed diets and increased calorie intake, weight gain, and elevated risk of cardiovascular diseases. Participants consuming ultra-processed diets ate an average of 500 more calories per day compared to those on unprocessed diets, putting on additional pounds over time.

Another reason to cut back consumption of highly processed foods: [recent findings](#) from the Columbia University Mailman School of Public Health and Robert N. Butler Columbia Aging Center suggest that following a healthier diet may slow down the [aging process](#) and reduce the likelihood of developing dementia. This underscores the impact dietary choices can have on overall health and [cognitive function](#).

Eating fewer ultra-processed, more nutrient dense foods is especially important for children and older adults, because their changing bodies require different energy needs and higher-quality consumed calories. But don't fret if you splurge on that mac and cheese or ice cream cone once in a while, Passarrello says. "Look at eating patterns over the course of a week, rather than day-to-day."

It can be easy to fall into habitual patterns, like relying on food delivery apps, take-out, or convenience foods, and hard to get out of, Passarrello adds. It means making a lifestyle switch of budgeting more time and more money to change behaviors. Start with small steps. For example, whenever possible, find ways to add more nutrient density to meals, like swapping out a side salad for French fries. She also suggested:

- Order off the children's menu to reduce portion size when dining out
- Add raw fruit to packaged breakfast cereal
- Learn to read food labels and choose products with fewer additives and more recognizable ingredients
- Prioritize whole or minimally processed food
- Adopt a holistic approach to dietary patterns and consider the cumulative impact of food choices over time
- Meet with a registered dietitian or nutritionist at least once or twice to create a food plan that works with your lifestyle, food preferences and budget
- Become an informed and empowered consumer to reduce your risk of poor health later on

## **How to spot ultra-processed foods**

According to the NOVA classification system, ultra-processed foods are industrial formulations made entirely or mostly from substances extracted from foods (oils, fats, sugar, starch, and proteins), derived from food constituents (hydrogenated fats and modified starch), or synthesized in laboratories from food substrates or other organic sources (flavor enhancers, colors, and several food additives used to make the product hyper-palatable). Beverages may be ultra processed.

### **Here are some examples of ultra-processed foods:**

- packaged snacks and cookies
- ice cream and frozen desserts
- chocolates, candies and confectionery
- cola, soda and other carbonated soft drinks
- ‘energy’ and sports drinks
- baked products made with ingredients such as hydrogenated vegetable fat,
- sugar, yeast, whey, emulsifiers, and other additives
- breakfast cereals and bars
- sweetened and flavored yogurts, including fruit yogurts
- dairy drinks, including chocolate milk
- meal replacement shakes
- pastries, cakes and cake mixes

## **11 Supplements That May Lower Blood Pressure**

High blood pressure (hypertension) can lead to serious complications like heart attack and stroke if not controlled. Continued management is needed to avoid such complications.



Managing blood pressure often involves medication and lifestyle changes. Supplements can also help lower blood pressure. Here are common supplements that may lower blood pressure.

## 1. Potassium

Too much sodium can raise blood pressure. Researchers believe potassium can reduce this effect because the more potassium you eat, the more sodium you wash away with urine.

Potassium can also help [lower blood pressure](#) by easing the tension in your blood vessel walls. The American Heart Association (AHA) and the World Health Organization (WHO) recommend increasing potassium intake to lower blood pressure.

The recommended daily potassium intake is about 3,400 milligrams for men and 2,600 milligrams for women. The AHA recommends having 3,500-5,000 milligrams of potassium daily to prevent or lower high blood pressure with potassium.

A potassium supplement can help you reach this recommended daily dose. You can also get potassium through dietary sources like bananas, apricots, and tempeh.

Potassium supplements are generally safe, but you may experience side effects like stomach pain, diarrhea, and vomiting. If you experience symptoms like mental confusion, leg heaviness, stomach pain, unusual bloating, or black stool after taking potassium supplements, call your healthcare provider immediately.

Potassium may also interact with blood pressure-lowering medications like Qbrelis (lisinopril), Cozaar (losartan), Lasix (furosemide), and Midamor (amiloride). Before taking potassium supplements, inform your healthcare provider about any other medications or supplements you take.

## 2. Magnesium

Studies have found [magnesium supplements](#) can help lower blood pressure and prevent [hypertension](#).

One analysis of 11 trials found a significant reduction in blood pressure among people who received magnesium supplements. Specifically, systolic blood pressure (the first number in a blood pressure reading) decreased by about 4.18 millimeters of mercury (mm Hg), and diastolic blood pressure (the second number) decreased by 2.27 mm Hg.

Some research shows magnesium may only be effective for lowering blood pressure in people with a [magnesium deficiency](#).

[Magnesium](#) has been successfully used in clinical trials at 365-450 milligrams daily. However, the maximum recommended dose from supplements or medications for people 9 years or older is 350 milligrams. Taking more than this may lead to side effects like diarrhea, stomach cramps, nausea, and, in cases of very high doses, irregular heartbeats.

You can also increase your magnesium intake from foods like spinach, almonds, and edamame.

### 3. Garlic

[Garlic](#) extract has been found to lower blood pressure in people with uncontrolled hypertension, either when used alone or with blood pressure-lowering medications.

Analyses of multiple studies have found that garlic supplements significantly reduced systolic blood pressure by 8-9 mm Hg and diastolic blood pressure by 5.5-7 mm Hg among people with hypertension.

The amount of garlic extract used in studies to lower blood pressure ranged from 480-1,200 milligrams.

Garlic extract is generally safe and tolerable. However, you may experience side effects like hot flashes, burping, gas, bloating, and dizziness.

Taking garlic supplements may also increase your risk of bleeding, which can worsen if you use blood thinners like warfarin (sold under brand names like Jantoven and Coumadin). Talk to your healthcare provider if you are planning to use garlic supplements with blood thinners.

## 4. Vitamin D

Research has shown that [low vitamin D levels](#) may increase hypertension risk. Therefore, vitamin D supplementation may help reduce or prevent the development of hypertension.

One study found that [vitamin D supplements](#) lower blood pressure in people with vitamin D deficiency who are over 50 years old and have obesity. Other research has found that long-term vitamin D supplementation may reduce the risk of developing hypertension, especially among those with vitamin D deficiency. However, using vitamin D supplements to lower blood pressure may not benefit people without a deficiency.

The dosage of vitamin D used to reduce blood pressure varied across studies, but most participants received between 800 and 2,000 international units (20 and 50 micrograms) daily.

While generally well-tolerated, potential vitamin D side effects include nausea and constipation. Vitamin D may also interact with certain medications like orlistat (a weight loss drug sold under brand names like Alli and Xenical), statins, steroids, and thiazide diuretics like Hygroton (chlorthalidone).

Vitamin D can also be obtained through sun exposure and certain foods, such as trout, salmon, and tuna.

## 5. CoQ10

[Coenzyme Q10](#) (CoQ10) is a natural enzyme that helps the body convert food to energy. Although the body makes CoQ10 naturally, it can also be obtained through food—such as meats, dairy, eggs, and legumes—and dietary supplements.

Research has shown that CoQ10 supplements may help reduce blood pressure, especially in people with diabetes and dyslipidemia (abnormal lipid levels). One study observed that using about 100-200 milligrams of CoQ10 supplements daily

gave the greatest benefit in blood pressure reduction. However, other studies have found mixed results on the benefits of CoQ10 in reducing blood pressure.

CoQ10 is generally well tolerated up to 1,200 milligrams daily. Some people may experience side effects like [insomnia](#) with doses over 100 milligrams daily. Other rare adverse effects of CoQ10 supplements include dizziness, light sensitivity, headache, heartburn, fatigue, and increased involuntary movements.

CoQ10 may interact with some medications like warfarin. It should also be used with caution in people with diabetes, especially those prone to [episodes of low blood sugar](#), as the supplement can lower blood sugar in some people.

## 6. Green Tea

Tea consumption, especially [green tea](#), has been found to reduce the risk of high blood pressure by about 10%.

One review found that green tea reduced systolic blood pressure by 1.98 mm Hg and diastolic blood pressure by 1.92 mm Hg. Other research has shown more mixed results, with some results showing green tea only significantly reducing systolic blood pressure, not diastolic.

Research shows that the benefit of green tea on blood pressure reduction was greater with a longer tea intake (three or months).

The doses of green tea used in clinical studies varied from 208-1,344 milligrams daily. However, studies found that low-dose green tea was often more effective in reducing blood pressure.

Green tea is generally safe. However, consuming about 400-4,000 milligrams of catechin (the active ingredient in green tea) daily can cause stomach pain, nausea, and discomfort.

Although uncommon, green tea has been associated with liver problems, especially for those who use green tea extracts in pill form. Consult your doctor if you have liver problems before using green tea supplements.

## 7. Calcium

[Calcium](#) supplements can help lower blood pressure. However, evidence appears stronger in people 35 or older and only moderate for younger people. People who are pregnant may also benefit more. The WHO recommends daily calcium supplements (1.5–2 grams of oral elemental calcium) for pregnant people with low dietary calcium intake to reduce the risk of [preeclampsia](#) (high blood pressure that occurs during pregnancy).

Most studies that have used calcium to reduce blood pressure have used it in doses of 1,500 milligrams or higher. Research has shown that the higher the calcium dose, the greater the drop in blood pressure. However, it's recommended that daily calcium intake stay below 2,000 milligrams as higher doses increase the risk of adverse effects.

Calcium supplements, especially those containing calcium carbonates, may cause constipation, gas, bloating, stomach pain, and, in severe cases, kidney stones.

Calcium may also interact with certain medications, such as Tivicay (dolutegravir), antibiotics, lithium, and levothyroxine (a thyroid hormone sold under brand names like Synthroid and Levoxyl). If you take any of these medications, it's important to maintain a significant time gap between calcium intake and medication use. Consult with a pharmacist for specific recommendations.

You can also get calcium from your diet by increasing your intake of milk, yogurt, cheese, and vegetables such as broccoli and kale.

## 8. Omega-3

There is moderate evidence to suggest that omega-3 supplements—particularly docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA)—can help lower blood pressure.

One analysis of data on 5,000 participants aged 22–86 found that adults who consumed 2–3 grams of combined EPA and DHA [omega-3 fatty acids](#) experienced an average reduction in blood pressure of 2 mm Hg compared to those who did not consume the fatty acids.

It appears that 3 grams of daily omega-3 fatty acid consumed in foods or supplements is the optimal dose to help lower blood pressure.

Omega-3 fatty acids are generally considered safe. However, it's recommended that the daily intake of EPA and DHA combined not exceed 3 grams from food and 2 grams from supplements. High doses may reduce immunity and cause bleeding problems. Other side effects include diarrhea, nausea, stomach pain, and fatigue.

Some food sources of omega-3 include fish, flax seeds, chia seeds, walnuts, and canola oil.

## 9. Beetroot

Beetroot, or simply [beet](#), has been extensively studied for its potential benefits in reducing high blood pressure. The vegetable is rich in substances like nitrate, betaine, anthocyanins, and flavonoids, which help lower blood pressure.

Beetroot can be consumed in different forms, including as a powder or juice supplement.

In one analysis involving 218 participants, people who consumed approximately 70-250 milliliters of beetroot juice experienced a significant reduction in systolic blood pressure. However, the effect on diastolic blood pressure was less pronounced.

Research suggests beetroot may lower blood pressure more effectively in people with underlying health conditions like obesity than in otherwise healthy people.

## 10. Melatonin

[Melatonin](#) is a hormone your brain makes. It regulates the sleep-wake cycle.

Research suggests that melatonin may also help lower blood pressure. However, the magnitude of its blood pressure-lowering effects varies among studies. Plus, only controlled-release melatonin appears to reduce blood pressure. Immediate-release melatonin did not have that effect.

In one study, controlled-release melatonin reduced systolic blood pressure by approximately 3.6 mm Hg. However, the effect was not statistically significant for diastolic blood pressure.

Melatonin supplements appear safe for short-term use, but there is not enough information on their safety in the long term. Potential side effects include drowsiness, nausea, and headaches.

Melatonin may also slow down the blood clotting process, increasing the risk of bleeding. It is best to avoid combining it with other supplements known to have blood-thinning properties, such as ginger, garlic, ginkgo, or ginseng.

## 11. L-Arginine

[L-arginine](#) is an amino acid converted in the body to nitric oxide, a potent chemical that helps widen the blood vessels.

Due to its effect on widening or relaxing blood vessels, L-arginine has been studied as a potential blood pressure-lowering agent. Research shows that L-arginine helps reduce both systolic and diastolic blood pressure in adults with hypertension. The effect may be greater in females than in males.

L-arginine has also been shown to lower blood pressure in pregnant women with preeclampsia. However, in these cases, a healthcare provider usually gives the L-arginine through a vein. It is unclear whether oral L-arginine has any effect on blood pressure in preeclampsia.

L-arginine may be safe when taken short-term. Adults have used oral L-arginine safely in doses between 1.5-24 grams daily for up to 18 months. Long-term use of L-arginine may accelerate the decline of kidney function and should be avoided, especially by older adults. Potential side effects of L-arginine include stomach pain, diarrhea, and bloating.

L-arginine can also be obtained from dietary sources like meat, fish, dairy products, and nuts.

**Editor's Note:** When buying a supplement, make sure the product is third-party tested. Unlike medications, supplements are not regulated by the FDA. This means their quality and safety can vary. Third-party testing confirms that the



supplement contains the ingredients listed on the label and is free from harmful contaminants. Check for seals from reputable organizations such as NSF International, USP (United States Pharmacopeia), or ConsumerLab.

## Other Tips for Lowering Blood Pressure

Hypertension has no cure, so managing blood pressure is a lifelong commitment. In addition to medication, incorporating certain lifestyle changes can help lower blood pressure. You could:

- Manage your weight
- Exercise regularly
- Reduce sodium intake
- Limit alcohol consumption
- Get quality sleep

## When To See a Healthcare Provider

Most people with hypertension do not experience any symptoms. It's important for adults to check their blood pressure regularly, even if they feel fine.

If your blood pressure is 180/120 or greater, wait a minute or two and then retake your reading. If the second reading is just as high, contact a healthcare provider about what to do. These readings could indicate hypertensive urgency.

If you have very high blood pressure and symptoms like severe headache, chest pain, blurred vision, nosebleed, difficulty breathing, and buzzing in the ears, see a healthcare provider immediately. This could be a sign of a hypertensive emergency.

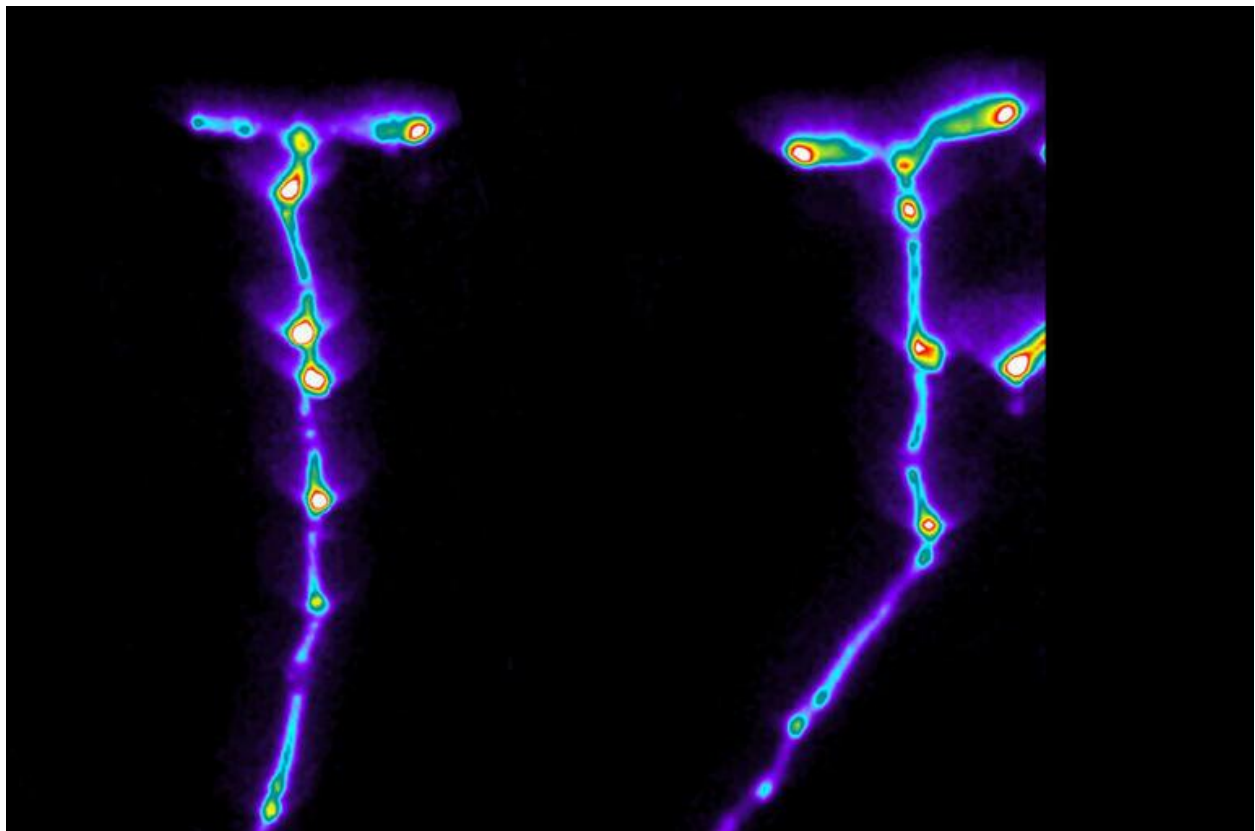
You should also see a healthcare provider if you experience any concerning symptoms when taking a supplement.

## A Quick Review

High blood pressure can be a serious health problem, especially if left untreated. Supplements like potassium, calcium, magnesium, vitamin D, garlic, and omega-3 fatty acids may help lower blood pressure.

If you have high blood pressure, your provider might recommend taking supplements as part of your management. They may also prescribe medication and lifestyle changes like reducing sodium intake, exercising regularly, and losing weight.

## Study finds what gets plant roots to grow strong



To investigate the significance of autophagy, the researchers developed a mutant *Arabidopsis* (thale cress) plant in which its autophagy was disabled which is shown on the right. With an enzyme from fire flies the researchers made it possible to distinguish the normal plant from the plant with its autophagy function disabled. The plant to the right has fewer light areas and thereby fewer potential places to grow new roots with its autophagy function turned off. Credit: Eleazar Rodriguez, Department of Biology, University of Copenhagen. © Provided by Phys.org

A biological mechanism familiar to people who fast helps plant roots grow strong. The discovery by University of Copenhagen scientists provides an answer to a long-unanswered question and a deeper understanding of the "mouths" of plants that can help to develop climate-resilient crops.

Imagine eating with your feet and having half your body underground. Such is the life of most plants, with roots as the mouths through which they eat and drink. Roots also serve to anchor plants and keep them safe in wind and rain. Indeed, roots are critical for a plant's life.

But many things remain unknown about the life of plants. How they grow their roots big and strong has long been a question and there are key pieces missing to the puzzle.

In a new study published recently, researchers from the University of Copenhagen's Department of Biology share their discovery of how plants control root growth.

It turns out that a beneficial clean-up mechanism in plant cells called autophagy plays a key role. The same mechanism exists in humans and is part of a popular health trend.

"Fasting has become popular as it seems to have a range of health-promoting effects in humans, as periods without food cause the body to activate a clean-up processes to dispose of various waste products in cells. In our study, we have proven that the same mechanism, which also exists in the plant kingdom, plays a vital role in the ability of plant roots to grow and absorb water and nutrients for the rest of the plant," explains Assistant Professor Eleazar Rodriguez from the Department of Biology, who led the study.

## **Roots have a 'heartbeat'**

It has long been known that auxin, a plant hormone, controls plant growth, root growth included. Auxin is a fuel for a kind of "heartbeat" that beats in each and every root tip of a plant. Roughly every four to six hours, auxin levels and the heartbeat in a plant's roots reach a maximum that causes new roots to grow.

"The movement of a root is almost like watching a snake slithering forward in search of water and nourishment in the soil. And we can see that the heartbeat is strongest every time the root meanders forth," says Rodriguez.

But how plants control their heartbeat so as to optimize root growth, has remained an unanswered question. This is where the plant's internal clean-up mechanism comes into the picture.

"In our experiments, we disabled the clean-up mechanism to understand its significance. Imagine if every garbage collector in Copenhagen went on strike—it wouldn't be long before trash filled the streets. The same thing happened in the plant cells, as the heartbeats that drive root growth became much weaker and went out of sync," explains Rodriguez.

Doing this allowed the researchers to conclude that the clean-up mechanism helps keep levels of different biochemical components in perfect balance to provide the most efficient root growth.

### **Can help germinate new climate-resilient crops**

According to the researchers, the new knowledge about plant roots may prove important in the fight against climate change. Extended periods of drought and floods are a new normal that place greater demands on food security. As such, the roots of the crops, which must be able to grow even in these harsh conditions.

"Numerous methods to change the genetic characteristics of plants are available today. These can be used to get plants to develop longer roots, faster, and in doing so, become more resistant to droughts or floods. One of the methods enlists the help of bacteria that live in symbiosis with the plant and can cause the plant to change its growth pattern. Several companies in Denmark are working on this right now," explains Ph.D. student Jeppe Ansbøl who co-authored the study.

The new knowledge applies to all flowering plants and perhaps more, according to the researcher. In principle, crops like tomatoes, potatoes, rice, wheat and corn could be altered to grow more and denser roots, because we now know how plants get their roots to grow.

"The more roots the plants have the more water and nutrients they can take, so the plants grow better faster. We're heavily dependent on plants because they feed us, extract CO<sub>2</sub> from the atmosphere and produce the oxygen we breathe. As such, it is extremely important to understand them fully, to which end we have just taken a big step forward," concludes Rodriguez.

## Causing the garbage collectors in cells to go on strike

Autophagy means "self-eating" and is a key mechanism when plants develop roots. To investigate the significance of autophagy, the researchers developed a mutant *Arabidopsis* (thale cress) plant in which its autophagy was disabled.

At the same time, they made the ARF7 protein luminescent, which is the protein that controls the auxin responses and which the plant cell's garbage collectors clean up to provide optimal root growth. The plant's garbage collectors collect waste from cells and transport it to a kind of recycling station in the plant called a vacuole.

"When we disrupted the plant's autophagy, there was waste everywhere, and we were able to detect the ARF7 protein among the waste," says Rodriguez.

**More information:** Elise Ebstrup et al, NBR1-mediated selective autophagy of ARF7 modulates root branching, *EMBO Reports* (2024). [DOI: 10.1038/s44319-024-00142-5](https://doi.org/10.1038/s44319-024-00142-5)

Provided by University of Copenhagen