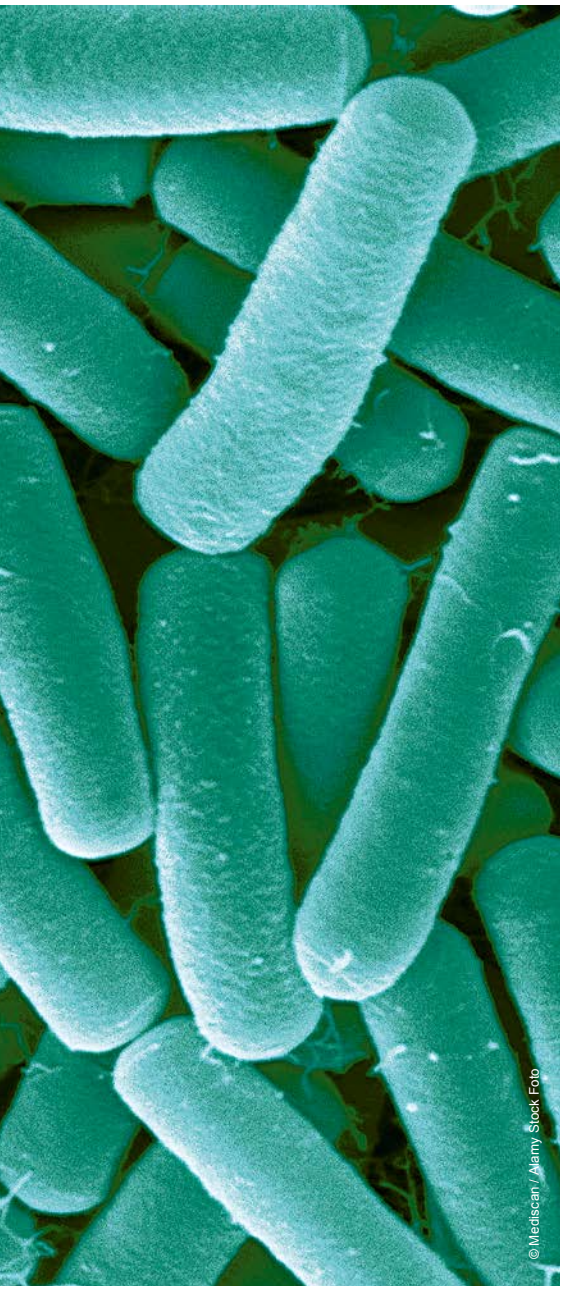


# The organic bacillus

**_Bacillus thuringiensis_ is a bacterium that likes to feed on insects. This makes it a widely used organic plant protection product. But are there any side effects?**




Look closely. The rod-shaped bacterium *Bacillus thuringiensis* (right, a scanning electron microscope image) can often be found on tomatoes.

Using a little imagination, *Bacillus thuringiensis* looks like a protracted fried egg under the electron microscope. The oval "egg yolk" inside the bacterium is the spore, durable like a permanent preserved food for times of hunger. In the spore, the microorganism's genetic material holds out for better times. But the "egg white" should not be underestimated as it contains a large diamond-shaped crystal. It turns out to be toxic cargo. If the bacteria enter the intestine of certain insects, the crystal consisting of protein breaks up. The protein breaks down the animals' intestinal wall, which then become paralysed and die within a day or two. *Bacillus thuringiensis* (Bt) now finds plenty of food in the insect carcass and can awaken from its "sleep".

Roughly translated, *Bacillus thuringiensis* means "Thuringian bacillus". The soil and plant dweller owes its name to the German microbiologist Ernst Berliner. He worked at the Institute for Cereal Processing in Berlin and found the bacteria in infested Mediterranean flour moth caterpillars. These had been sent to the institute from a mill in Thuringia in 1909.

## The insecticidal toxin poses no danger to humans

Little did Berliner know that many decades later, Bt would make a career out of being a plant protection product. Today, the spores and the toxin are used against pests all over the world such as the European corn borer or cabbage butterfly. Based on what we currently know, the Bt protein used as an insecticide is harmless to humans, acts specifically on certain insect species depending on the variant, spares many beneficial insects, is easy to use and is even environmentally friendly. Bt compounds have, therefore, become practically indispensable, particularly in organic farming.

Organic pesticides are regularly reviewed by the European assessment authorities, as are conventional "chemical" plant protection products. The BfR is also involved in the health risk assessment of active substances and products. Several Bt active substances are currently undergoing the process of re-evaluation and renewal of the approval. Only after an extensive and EU-wide scientific review by the European Food Safety Authority (EFSA) and the competent authorities of the member states can the approval of the active substance be renewed by the EU Commission. The EU-wide approval is in turn the prerequisite for the authorisation of plant protection products in the respective member states.

## Bacillus species can cause diarrhoea

However, this review is not simple. The main reason for this is the fact that *Bacillus thuringiensis* is part of a group of closely related Bacillus species. This Bacillus cereus group includes 18 species, including its namesake *Bacillus cereus*. In practice, the group members are usually not treated separately. However, some of them can cause gastrointestinal illnesses if they are ingested via food. The key question for EFSA assessors: might bacteria from organic pesticides also trigger these diseases? Does this make them a source of danger? Let's look for an answer.

The cause of human diseases due to members of the *Bacillus cereus* group are other bacterial toxic substances that have nothing to do with the "useful" Bt protein against insects. One of these toxins, cereulide, causes vomiting. However, it has not yet been discovered in Bt strains. Enterotoxins are much more common than cereulide. These are toxic substances that can cause diarrhoea. The genetic make-up (genes) for this can also be detected in Bt.

The diseases are usually mild, rarely last longer than 24 hours and are not contagious. Nevertheless, if Bt spores are used as an organic pesticide, there is a possibility that they could be ingested in larger quantities with fruit or vegetables, for example, and "germinate" in the human intestine. The more Bt spores enter the body in this way, the greater the risk might be of getting diarrhoea.

## Bacteria from organic pesticides are found on peppers and tomatoes

Dr. Hendrik Frentzel, biologist at the BfR, and his team have checked how often and in what quantity Bt from organic pesticides are found on vegetables. In doing so, they closed a significant knowledge gap for EFSA assessors. They found *Bacillus cereus* species on peppers in 41 per cent of cases; on tomatoes it was 28 per cent. 93 per cent (peppers) and 99 per cent (tomatoes) turned out to be Bt.

Frentzel and his colleagues took a closer look at some of these bacterial findings, known as isolates. They wanted to know how many of them came from spores of sprayed Bt. The result: more than half of the isolates from pepper and tomato samples examined came from organic pesticides.

Does this mean there is a health risk now? Furthermore, the "dose" of the microbes found, in other words the number of them, can provide information on this. It was within the tolerable range with very few exceptions. This is reassuring. Nevertheless, Frentzel thinks that it is necessary to further investigate possible health risks from Bt. "*Bacillus thuringiensis* is a useful alternative to chemical pesticides," he says. "But 'organic' does not automatically equate to harmless."

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## What happens with the spores in the environment?

"We need more information about what happens to the spores after they are spread on the field," says Dr. Sabrina Feustel. She is in charge of the health risk assessment of Bt at the BfR. In the field, the spores are largely inactivated by ultraviolet radiation from the sun. It is a different matter in the greenhouse, where the spores can survive longer. On the other hand, the use of Bt against insects in the forest, such as the oak processionary, is less problematic. Its caterpillars have long "stinging hairs" that cause severe skin reactions. These are particularly dangerous to those working in forests.

It must also be taken into consideration that Bt and its relatives are widely distributed in nature and are frequently found in the soil, for example. Fewer than 100,000 of these "bacilli" per gram of food are considered acceptable. This is used by the BfR as a reference value for the assessment. This value should not be exceeded if plant protection products are used properly. However, the risk assessment is complicated by the fact that the formation of toxins varies according to the strain of bacteria.

Therefore, there are quite a few questions that still require more precise answers. Nevertheless, Sabrina Feustel agrees with the assessment of her colleague Hendrik Frentzel. She sees organic pesticides as alternatives that complement chemical active ingredients, however, there are many areas in which they cannot be completely replaced. As with chemical pesticides, an extensive health risk assessment is essential for organic pesticides. "This year, I will use Bt for the first time on cabbage and boxwood," says Feustel. "I am curious to see how they stand up to the caterpillars."

## Bt plants: banned in Germany

No article on Bt would be complete without referring to plant genetic engineering. The genetic blueprint for Bt insecticide has been integrated into the genome of crops, such as corn and cotton by seed producers, so that they now produce their own insecticide and fight off predators. Such plants are grown in countries like the USA, India and China. The use of chemical insecticides in corn fields, for example, has declined significantly since then.

In the EU, only a single type of Bt corn is approved as a genetically modified plant. However, in light of the opposition to plant genetic engineering, Germany has chosen to prohibit growing this type in this country as well. Not all Bt is created equal, it seems. ◘