



# From the trough *to the plate*



What livestock eat can end up in their meat, eggs or milk. The BfR investigates which undesirable substances end up in foods of animal origin and to what extent.

**I**n the early 19th century, a mysterious disease drove settlers in the western USA to despair. Thousands of people died, but nobody knew why. A few years later, the physician Anna Pierce Hobbs Bixby found out that the cause was white snakeroot, a plant eaten by cows and

sheep. The animals remained healthy, but the toxin tremetol evidently passed from the feed to the milk and meat. Those who drank or ate them fell ill with the dreaded “milk sickness”. The consequences: loss of appetite, vomiting, coma – and even death. The best-known victim was Nancy Hanks Lincoln, mother of former US President Abraham Lincoln.

## PFAS

*Per- and polyfluoroalkyl substances (PFAS) are often part of industrial processes due to their special chemical properties and are used in numerous products, such as paper, textiles and non-stick pans. PFAS are resistant to degradation and thousands of different compounds of its kind accumulate in the environment and in the food chain. Many of the PFAS studied so far affect the immune system, lipid metabolism and the liver.*

## Cannabinoides

*are contained in the leaves and flowers of the hemp plant. One of the best-known of these psychoactive (intoxicating) substances is tetrahydrocannabinol – THC for short. Even small amounts of THC can affect the central nervous system and the cardiovascular system. Possible consequences include mood swings and fatigue.*

## Alkaloids

*In addition to vitamins, minerals and dietary fibre, plants produce phytochemicals, such as alkaloids, which repel potential predators. Alkaloids deter pests, but they can also be harmful to human health. There are thousands of different alkaloids that can be found in potatoes, lupine seeds and weeds.*

Bixby's findings were not published until 1928. Consequently, milk sickness remained unknown to the medical community for more than a century. Today, it only rarely occurs. Scientific findings, strict controls and numerous laws have strengthened the safety of feed and food. However, despite all efforts along the supply chains, animal feed can occasionally become contaminated with undesirable substances, including plant and fungal toxins, and other environmental contaminants, such as per- and polyfluoroalkyl substances, or PFAS for short (see box).

The German Federal Institute for Risk Assessment (BfR) uses feeding studies with agricultural livestock to investigate whether these substances can also pass into food. The aim is to assess the health risks posed by these substances to humans and animals. "If important data on these substances is missing with regard to their occurrence in animal feed, metabolism in animals or transfer, for example, into milk, it is our task to close any such knowledge gaps," says Dr Robert Pieper, who is responsible for topics related to safety in the food chain at the BfR.

## INTOXICATING SUBSTANCES IN MILK

Reliable data on feeding effects was also missing when reports emerged more than ten years ago that some farmers in Europe wanted to feed industrial hemp to cows. Although the European Food Safety Authority (EFSA) had evidence that cannabinoids (see box) – especially the intoxicating tetrahydrocannabinol (THC) – could pass into milk, it was unclear how much, and what this meant for human and animal health.

The BfR investigates which substances pass from feed to meat and milk.



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This is why the BfR began studies in 2016. The first clear results came from a pilot study with only one dairy cow that was fed industrial hemp silage. Silage is feed preserved by fermentation. “We saw that the cow reacted. She became tired and her ears drooped,” says Dr Robert Pieper. The BfR explored this lead in a large-scale study with ten dairy cows.

The result of the study was published in a renowned international scientific journal: even when being fed industrial hemp with relatively low THC concentrations (below 0.2 percent), the animals experienced behavioural changes and health impairments. Their breathing and heart rate slowed. The cows became sleepy, unsteady, ate less and gave less milk. It demonstrated that even a small addition of industrial hemp silage to a dairy cow’s rations leads to cannabinoids passing into the milk.

**“The cow became tired and her ears drooped.”**

DR ROBERT PIEPER, BFR



How much of a substance in feed can reach foods of animal origin depends on the substance in question.

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### ABSORPTION, ACCUMULATION, EXCRETION

In general, anything an animal eats can enter its bloodstream and from there reach the meat, eggs or milk. This depends on how the substance in question is absorbed in the animal's gastrointestinal tract, then metabolised and excreted again. "There are big differences between substances," says Dr Jorge Numata, who works on mathematical modelling of substance transfer from feed to foods of animal origin at the BfR.

For example, lupine alkaloids (see box on previous page) are broken down and excreted very quickly. If they are no longer present in the feed, they stop appearing in the milk after a short time.

The situation is different with cannabinoids: for THC, it takes a few days after stopping the feeding for the concentration to drop noticeably. Further, some PFAS remain in the body for a very long time – they can be detected in animal-based food for weeks, even though the animals have already stopped eating contaminated feed.

### WEB APP FOR MONITORING AUTHORITIES

The findings from the feeding experiments are also the basis for predictive mathematical models. For example, if a monitoring authority learns that maximum levels in food were exceeded, the causes must be investigated and the next steps carefully considered. To support monitoring



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and risk management in such cases, the research team around Pieper and Numata has developed the web app “ConTrans” from the feeding studies and predictive models derived from them. ConTrans can estimate the transfer of undesirable substances from feed into food and can be used as a decision-making tool.

### GROWING WORLD POPULATION AND CLIMATE CHANGE

However, it is not just a matter of preventing acute crises. Experts at the BfR are looking further into the future to assess whether animal feed will still be safe in 20 years and what can be done to ensure this. “Competition for food between humans and animals will increase and influence agricultural

production and animal farming,” says BfR President Professor Dr Dr Andreas Hensel (see interview next page) Therefore, it is becoming increasingly important to survey what is edible for humans: where do we stand in competition with animals? What can still be used as food, and what as animal feed? Are there health risks?

To meet the challenges of globalisation, a growing world population and climate change, animal farming systems must be further developed. Settlers in the past did not yet have this foresight. When feed became scarce because there was not enough rain and the pastures dried up, they let their cattle roam freely in the forests – where they came across the white snakeroot. —

#### More information

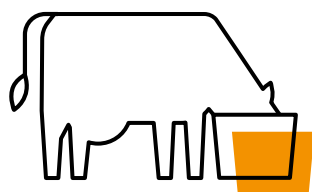


Wagner, B. et al. 2022. **Transfer of cannabinoids into the milk of dairy cows fed with industrial hemp could lead to  $\Delta^9$ -THC exposure that exceeds acute reference dose.** Nature Food 3, 921–932. DOI: 10.1038/s43016-022-00623-7



BfR information  
“Animal feed”

## BfR survey: Animal feed



BfR online survey of 1,000 consumers and 251 farmers in Germany, survey period 30 August to 13 September 2022.

**More than 60 %** of the consumers questioned believe that feed may pose health risks to them. Antimicrobial resistance (22 %), exposure to undesirable substances (16 %) and allergy risks (13 %) are mentioned most frequently. Of the farmers questioned, only 14 % have this opinion.

**More than 90 %** of the farmers questioned and more than 60 % of the consumers questioned rate the safety of feed that comes from the farms’ own products or from Germany as safe or very safe. Conversely, feed purchased from other EU countries is considered less safe by both groups.

**19 %** of the farmers questioned suspect that the specified maximum levels for pesticide residues in feed are frequently or very frequently exceeded. In contrast, more than 60 % of the consumers questioned assume that this is the case.