

The proposal to choose ricin as the “Poison of the Month” comes from the Working Group on Regulatory Toxicology...

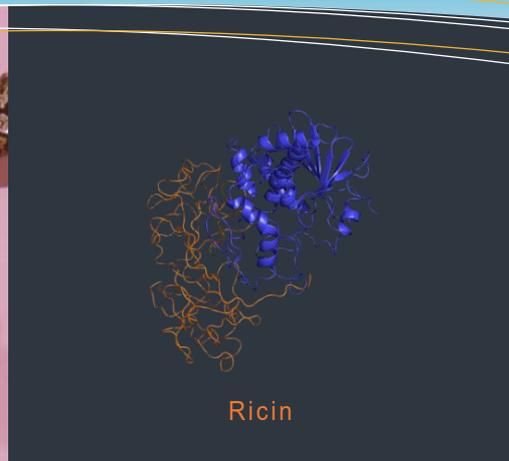
which selected ricin as an example of a poison for which regulation focuses primarily on misuse prevention and hazard control. The management of this highly potent acute toxin is therefore not based on limit values, but on prohibitions, restrictions on possession and handling, and international agreements (OPCW). Ricin thus illustrates the role of regulatory toxicology at the interface of chemistry, security, and law.

Lectins

From a chemical perspective, ricin is a lectin. Lectins are a group of proteins characterized by their ability to bind specifically to sugar structures (carbohydrates) without chemically modifying them. They occur in plants, animals, and microorganisms and fulfil a wide variety of biological functions. In plants, lectins are often involved in defense mechanisms, for example against herbivores or microorganisms.

Other well-known plant lectins include abrin from the seeds of the rosary pea (*Abrus precatorius*) and phytohemagglutinin from beans.

Binding occurs specifically to terminal sugar residues of glycoproteins and glycolipids on cell surfaces. Through this selective carbohydrate recognition, lectins can modulate cell–cell interactions and signal transduction processes, trigger or enhance



Ricin from the castor bean plant – a natural toxin with a political history

Ricin is considered one of the most notorious poisons of the 20th century. It is tasteless and odorless and highly toxic even at the lowest concentrations. In humans, ingestion of less than 2 mg can already be fatal. In addition, symptoms occur only after a delay, are non-specific, and the severity of poisoning is therefore recognized late. Ricin has been investigated for use as a potential weapon of war and sabotage, has been used in intelligence operations, and is now internationally banned. The toxin became famous at the latest in 1978, when the Bulgarian dissident Georgi Markov died in London after an apparently harmless prick with an umbrella. Less well known is that the same substance comes from the seeds of a plant that is grown worldwide as an ornamental and whose oil is used in cosmetics and medicinal products. This unusual combination of everyday presence and extreme toxicity makes ricin particularly challenging from a regulatory perspective.

The castor bean plant (*Ricinus communis*) originally comes from tropical East Africa and was already spread in antiquity via North Africa, the Mediterranean region, and Western Asia. Today it grows worldwide and is increasingly cultivated as an ornamental in temperate zones as well. Of primary economic importance is castor oil obtained from its seeds. Toxicologically relevant, however, is not the oil itself, but the protein ricin contained in the seed. The fat-insoluble, water-soluble toxin remains in the press cake when the oil is properly extracted, which is why the oil is considered toxin-free. Nevertheless, relevant exposure can already occur through ingestion or chewing of the seeds.

Ricin is among the highly potent natural toxins. Its effects are almost exclusively due to its acute toxicity. The mechanism of action is based on a targeted disruption of key cellular functions, in particular protein biosynthesis, which can rapidly lead to loss of function of affected cells and organ damage. Inflammatory reactions, vascular injury, and disturbances of the microcirculation contribute to the systemic clinical



endocytosis, and, as docking and mediator molecules, facilitate the entry of other ligands, particles, or pathogens into the cell.

Cellular mechanism of action of ricin

Ricin belongs to the type II ribosome-inactivating proteins (RIPs) and is a heterodimeric glycoprotein composed of two functionally distinct polypeptide chains, the B chain (RTB) and the A chain (RTA), which are linked by a disulfide bond. Its target is the ribosome, a central cellular structure in protein biosynthesis.

The B chain acts as a lectin and binds to galactose-containing sugar structures on the surface of eukaryotic cells. These widely distributed structures explain ricin's lack of tissue specificity. After binding, the toxin is taken up by endocytosis; a small, but toxicologically crucial, fraction escapes lysosomal degradation and is transported via retrograde trafficking to the endoplasmic reticulum.

There, the disulfide bond is reduced and the A chain enters the cytosol. As an RNA N-glycosidase, it removes a single adenine base from the sarcin/ricin loop region of 28S rRNA. This minimal structural damage results in irreversible inactivation of the ribosome. Only a few active molecules are sufficient to completely block protein synthesis and trigger cell death.

picture.

The clinical course of ricin intoxication is strongly dependent on the route of exposure. After oral ingestion, for example through consumption of seeds, symptoms typically occur after six to twelve hours. Early signs are nausea, vomiting, and diarrhea, often accompanied by severe fluid loss, muscle pain, as well as signs of liver and kidney damage. In severe cases, seizures may occur. Fatal courses are rare, but can occur after three to five days as a result of circulatory collapse and multi-organ failure.

The course is considerably more severe after parenteral exposure, when ricin enters the bloodstream directly. Severe pain at the entry site is described shortly after exposure, followed by fever, vomiting, and a pronounced feeling of illness. As the condition progresses, hypotension, tachycardia, muscle cramps, shock, and multi-organ failure develop. Death can occur within 36 to 48 hours.

After inhalational exposure, respiratory symptoms predominate. Four to eight hours after exposure, cough, shortness of breath, bronchoconstriction, and tachycardia occur. Severe inflammatory lung injury, pulmonary edema, and circulatory failure may follow. Lethal courses are often observed within 36 to 72 hours.

No specific antidote therapy exists. Treatment of ricin poisoning is symptomatic and may include gastric lavage or medically indicated adsorption measures, as well as stabilization of respiration, circulation, and organ functions.

Beyond medical toxicology, ricin is of considerable security-policy relevance, which is why it is listed under the Chemical Weapons Convention and is subject worldwide to strict controls and prohibitions.

By Ute Haßmann

Literature and links:

- [RKI - RKI-Ratgeber - Rizin-Intoxikation](#)
- [Ricin Poisoning: A Comprehensive Review | Clinical Pharmacy and Pharmacology | JAMA | JAMA Network](#)
- [Ricin: structure, mode of action, and some current applications](#)
- [Schedule 1 | OPCW](#)
- Federal Office for Economic Affairs and Export Control (BAFA), information on the Chemical Weapons Convention (CWC), restrictions on Schedule 1 chemicals for research, industry and trade
- Foto of [CDC](#) on [Unsplash](#)

