

Straight Tox

Ricin

by Dwain Fuller, D-FTCB, TC-NRCC

On February 14th, 2008, what seemed like a routine call to a Las Vegas 911 operator from a man suffering from respiratory problems became an incident of far-ranging significance. At last report, the man, now identified as Roger Von Bergendorff, a down-and-out graphic artist, was in critical condition in Spring Valley Hospital, and by at least one report, comatose.

The cause of his condition was not discovered until two weeks later, however. At around 2:30 p.m. on February 28th, Thomas Tholen, a cousin of Von Bergendorff, was cleaning out the Extended Stay America room that Von Bergendorff had rented, and from which he was now being evicted, when he came across a small vial. Mr. Tholen took the vial down to the motel's front desk which set in motion a massive police, hazmat and Homeland Security response. The content of the vial was determined to be ricin.

Ricin is a toxin derived from castor beans. Its mechanism in the body is to inhibit protein synthesis. As a result of this inhibition, the cells are deprived of essential proteins and die. Thus ricin is a systemic poison affecting multiple systems of the entire body.

Castor Beans

Castor beans come from the castor bean plant (Ricinus communis) which has been cultivated for centuries, primarily for the oil produced by its seeds, or beans. The Egyptians burned castor oil in their lamps more than 4000 years ago. Castor oil, is perhaps best known to the lay person as a popular stimulant laxative of the early 20th century. As a child of the 60's, I have never experienced the joys of castor oil, but merely broaching the subject in my workplace initiated a torrent of stories of the horrors of taking castor oil. The aversion to the medicinal use of castor oil seems to lie in its taste rather than its effects.

There are many non-medical uses of castor oil as well. In the United States, castor oil has been used in aircraft lubricants, hydraulic fluids, synthesis of soaps, linoleum, printer's ink, nylon, varnishes, and in the manufacture of explosives. The seeds, stems and leaves of the castor bean plant all contain ricin. Although prepared by the pressing of castor beans, due to ricin's insolubility, however, castor oil does not contain ricin, unless cross-contaminated during the oil's production. The seed pulp left over from the pressing of castor oil contains about 5% ricin by weight. While it has been estimated that as few as four to eight castor beans would be toxic or even fatal to an adult human, the fact is that unless the seed coat is broken, such as by chewing, castor beans will likely pass through the body with no ill effects. Perhaps in testimony its relatively benign nature when not purposely abused, some varieties of the castor bean plant are often grown as ornamentals. They are best adapted to the soils and climate of southeastern Kansas and Missouri, southern Illinois and Indiana, as well as Tennessee, Kentucky, and parts of Oklahoma and Texas.

Castor Bean Plant

While castor beans do not appear to pose too much of a threat, ricin itself, however, is a potent toxin. The estimated toxic dose for an adult is less than 1 milligram if inhaled or injected. There is no known antidote for ricin poisoning. Instead only symptomatic and supportive treatment is available and long-term organ damage is likely in survivors. The symptoms of ricin poisoning are dependent on the route of administration. If inhaled, the symptoms are: respiratory distress, fever, cough, nausea, and tightness in the chest. These are followed by pulmonary edema, hypoxia, cardiac arrhythmia, and death. If ingested, the symptoms are: vomiting, diarrhea, perhaps becoming bloody, followed by severe dehydration. Within several days the person's liver, spleen and kidneys may fail, leading to death.

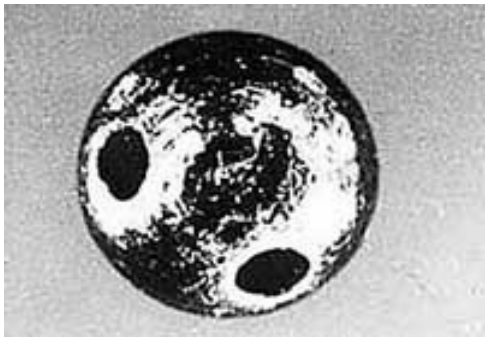
Ricin was evaluated by the United States for its potential as a military weapon during World War I. At that time it was being considered for use either as a toxic dust or as a coating for bullets or shrapnel. Due to the technological limitations of the time the dust-cloud concept could not be adequately developed and the bullet/shrapnel coating concept would be a violation of the Hague Convention of 1899. During World War II the United States and Canada studied the potential for the use of ricin in cluster bombs, but concluded that due to the necessity to aerosolize it as a dust, it was no more economical than phosgene.

Perhaps the most interesting chapter in the history of ricin is the incident of Georgi Ivan Markov. Georgi Markov was a Bulgarian-born novelist and playwright. Markov enjoyed a privileged existence in Bulgarian society even though his father was considered a "class enemy" of the communist party. This all ended, however, in 1969 when he defected to Italy after learning that his latest play had angered the government and put him at risk. After his defection he was

accused and convicted by Bulgarian authorities, in absentia, of being a traitor. By 1971 Markov had immigrated to Britain where he became a broadcast journalist and commentator for the BBC. In, June of 1975, he began contributing programs to the CIA-funded, Radio Free Europe, where his weekly shows were sharply critical of Bulgarian bureaucrats and communist party officials, especially, party leader, Todor Zhivkov.

In early 1978, Markov began receiving death threats. In the last call in August of 1978, Markov was told that he would die of natural causes, killed by a poison the West could not detect nor treat. Two weeks later on September 7th, Markov parked his car in a parking lot on the south side of Waterloo Bridge in London. This was his usual parking spot where he would catch the bus to BBC headquarters. While waiting at the bus stop, Markov felt a sharp prick in the back of his right thigh. When he turned around he saw a gentleman bending over to pick up a dropped umbrella. The man said "I'm sorry" in a foreign accent, promptly hailed a cab, and left.

Markov, although in pain, continued on to work where he told his colleagues what had happened. On the back of his right thigh was a swollen pimple-like wound. That evening he developed a high fever and by the next day was having trouble talking. He was admitted to the hospital where he was initially treated for septicemia, but over the next few days Markov began to have bloody vomit and kidney failure. On September 11, 1978, his heart failed. Georgi Markov was dead.



Pellet recovered from Georgi Markov

At autopsy it was determined that Markov's lungs were full of fluid, his white blood cell count was extremely high, his liver was damaged, and his lymph nodes, intestines and heart were riddled with small hemorrhages. A large portion of tissue was removed from around the wound area on the back of Markov's right thigh. In this tissue examiners discovered a small pellet 1.52 mm in diameter composed of platinum and iridium. The pellet was eventually determined to be a watch bearing, but in this pellet were two 0.34 mm holes bored at right angles to each other, forming an X shaped well inside. Due to the extreme hardness of this material it was surmised that such precision machining could only have been done by a sophisticated laser process known as "spark erosion."

Although no poison was detected in the pellet, nor in Markov's body, it was surmised due to strong circumstantial evidence, based on Markov's symptoms, postmortem pathology, and intelligence information regarding the Soviet Union's involvement in research of the use of ricin as a weapon, that Markov did in fact die of ricin poisoning administered via the pellet propelled from a gas powered

device disguised as an umbrella. Although the Soviet Union has denied any connection to the incident, KGB defectors, Oleg Kalugin and Oleg Gordievsky, have since confirmed the Soviet Union's involvement.

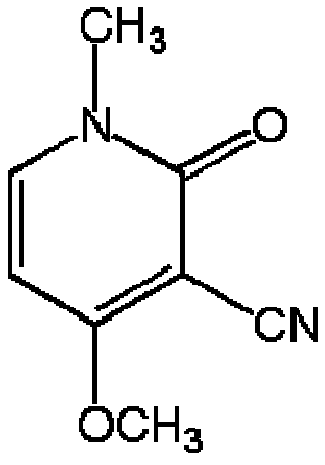
Ricin A - blue, Ricin B - red

Ricin consists of two distinct protein chains with a molecular weight around 30 kDa each. Ricin A is an N-glycoside hydrolase that targets and depurinates an adenine base in the 28S rRNA molecule of the ribosome, resulting in an inhibition of protein synthesis. Ricin B is a lectin that binds galactosyl residues and is important in assisting ricin A's entry into a cell by binding the cell surface component. It is the presence of both of these chains that renders ricin so toxic. Many plants such as barley have the ricin A chain but not the ricin B chain. Since people do not get sick from eating even large quantities of such products, the ricin A chain is relatively harmless without the ricin B chain present.

Ricins may have therapeutic use in the battle against cancer. It is theorized that Ricin could be linked to a monoclonal antibody to target malignant cells recognized by the antibody. It has also been postulated that one may be able to use the ricin B chain as a vehicle to effectively deliver antigens into cells thus greatly increasing their immunogenicity.

The fact that ricin is a complex protein of extremely high molecular weight presents an unusual problem for the forensic toxicologist. On one hand, these characteristics of ricin make it relatively well-suited for detection by a properly designed immunoassay, and many of these have been described in the literature. However due to its high molecular weight and complex structure, confirmation by electron-impact GC/MS or LC/MS, the standard tools of the forensic toxicologist, is not possible.

However, while not fully explored in human subjects, the literature suggests that a biomarker of ricin exposure, ricinine, may be easily detected by standard solvent extraction and GC/MS or LC/MS technology. Ricinine is not a metabolite of ricin, but rather a biomarker that derives from the same source as ricin, the castor bean plant. Thus confirming the presence of ricinine in biological fluids that have screened positive for ricin by immunoassay greatly enhances evidence of ricin exposure or poisoning. Ricinine ($C_8H_8N_2O_2$) has a molecular weight of 164 daltons and thus is quite amenable to analysis by routine GC/MS or LC/MS technology.



Ricinine

Update:

Near the completion of this article it was reported that Roger Von Bergendorff had recovered and upon his release from the hospital on April 16th, 2008 was arrested and charged with possession of a deadly toxin. Mr. Von Bergendorff allegedly admitted making ricin in what he described as an "exotic idea" to harm his enemies. Found, among other clandestine items, at a self-storage rented by Von Bergendorff, was a safe containing a ricin contaminated mortar and a drawing made by Von Bergendorff of an injection device disguised as a pen.

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