Ricin Toxin: A Military History

By Mr. Reid Kirby

Since the late 1980s, there has been a growing concern that terrorists might adopt chemical and biological weapons. Ricin (Agent W)[1]—due to its simplicity in extraction, availability of materials, toxicity, and a few would-be attempts to acquire it—has been a prominent counterterrorism concern. This concern stems mostly from the toxicity of ricin and partially from its little-understood military history.

Origins

The source of ricin, the castor bean, has been a well-known poison since ancient times. Ingesting two to four seeds induces nausea, muscle spasms, and purgation—eight seeds leads to convulsions and death. Castor oil (which makes up over half the weight of these seeds) has been used in ancient India, Egypt, and China as a cathartic and to treat sores and abscesses. Today, castor oil is an important industrial feedstock for numerous manufacturing processes and also is used as a lubricant and a laxative.

The castor bean plant (*ricinus communis*) is a 4- to 12-foot shrub-like herb originating in Southeast Africa, but it has a worldwide distribution. It is cultivated throughout the United States as an ornamental plant. Carl Linnaeus, the 18th century botanist, derived the plant's taxonomic name from the Latin word *ricinus* (tick) because of the appearance of its seeds and the word *communis* (common) for its distribution. The term ricin was coined in 1888 by Herman Stillmark to name the toxic proteinaceous substance he extracted from the castor bean for his agglutination experiments.[2] This plant holotoxin was later used in Paul Ehrlich's famous immunology experiments.

***Ricinus communis*, the castor bean plant**

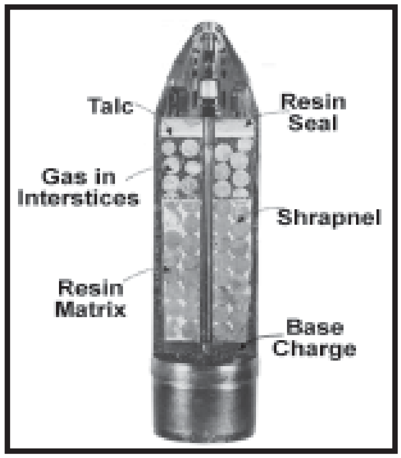
As a tool in science, ricin has contributed to early immunology, the treatment of cancer, and the understanding of cell biology. Its military history began during World War I as America's first venture into biological warfare, but ricin faded into obscurity after World War II when it was surpassed by the much more potent botulinum toxin A (Agent X)[3]. Eventually, ricin would gain notoriety as an espionage tool of assassination and would often be mentioned by potential terrorists. This brief military history of ricin illustrates the synergy required for a workable weapon system and the ethical issues it posed. Ricin proved difficult to weaponize for an aerosol effect, and where it was not difficult to weaponize, it represented an ethical dilemma.

World War I

During World War I, the U.S. Bureau of Mines studied the offensive potential of ricin at the American University Experimental Station. Two weapon concepts were considered: the simplest approach was coating shrapnel and bullets with ricin to create a skin effect; the more challenging concept was a "dust cloud" that produced a lung effect. At the time, limited experimental work on animals demonstrated that it was possible to weaponize ricin. Interestingly, the average time it took for an animal to die was somewhat longer than is reported in contemporary studies. This early work also identified the main technical difficulty in weaponizing ricin: its thermal sensitivity. It was found that the heat generated while firing the coated bullets destroyed a significant amount of the agent.[4]

The recommendation at the time was to investigate ricin-coated shrapnel or bullets immediately but hold off on a dust cloud weapon until an antitoxin could be made available. This posed the ethical dilemma mentioned earlier: a lung effect from ricin was an acceptable form of chemical warfare, but ricin-coated shrapnel and bullets were considered to be an act of poisoning and thus were ethically prohibited.[5] Ricin-coated shrapnel and bullets were only to be used in retaliation *(lex talionis,* the law of retaliation) against the Germans if they used a similar "poisoned" weapon.

By the end of the war, researchers could only weaponize ricin in coated shrapnel and bullets or by using a dust cloud for a blinding-eye effect[6] (the lung effect from a dust cloud could not be confirmed). Though four manufacturers had been identified and the U.S. Army desired to have three field trials with ricin, time and ethics prevailed, and the war ended without a usable weapon. Given its atrocious reputation, researchers felt that all records on ricin should be kept secret or destroyed.[7]



Cutaway of a 75-millimeter shrapnel shell intended to deliver a dry-type agent (probably a vomiting agent).

World War II

Early in World War II, England and Canada began work on ricin for use in 4-pound bursting bomblets.[8] The French also had an interest in ricin but, like early U.S. investigators, felt that it was too dangerous to study without first having an antitoxin.[9] The U.S. military's interest in ricin resurfaced around 1942 as a project of the National Defense Research Committee[10] and led to chamber and field trials at Dugway Proving Ground, Utah, in 1944.[11] These efforts differed from those of the previous war in that only a lung effect was being considered, and considerable advances had been made in the science of aerosols.[12] However, the thermal sensitivity of ricin remained the major technical hurdle.

Theoretically, there is about 1 gram of pure ricin per kilogram of cold-pressed castor bean cake. Given the U.S. production of castor oil during the war, 1,000 tons of ricin could have been produced annually. The agent's most basic form was an amorphous mass termed "crude" ricin, and it was essentially the form with which World War I investigators had worked. To get the agent into this usable aerosol form, it needed to be added to a volatile solvent (fluidized) or milled into a fine powder (micropulverized).

Fluidization was successful, but it seriously diluted the amount of agent that could be employed. Micropulverization of a dry-type agent was the preferred method, and ball milling (the common method of the time) was used first. During the milling, the heat from the friction was too extreme, and the agent was almost entirely destroyed, so an alternate method of milling and drying had to be developed. Spray-drying the agent and using a specially designed chilled-air grinder produced an agent that had lost little toxicity. This was the formulation that was termed *Agent W* throughout field trials.

There were three field trials at Dugway Proving Ground in May 1944. Two used a bursting munition resembling the standard 4-pound biological bomblet, and another used a tail-ejecting spraying munition. The tests were conducted in the G-2 Canyon Test Site on the northern slope of Granite Peak. Katabatic winds blew the aerosol cloud over 50, 100, 200, and 400 sampling arcs. The trials indicated that ricin was only lethal as long as the cloud was still visible to the unaided eye.

A pilot manufacturing plant produced 1,700 kilograms of ricin. Planners designed a $127,000 full-scale plant for producing micropulverized crude ricin, which would have been capable of producing 26 pounds of agent a day at $13 a pound (in 1944). Between 1943 and 1944, a crystallization method was also developed that produced a more potent agent. It has been suggested that there were field trials with the crystallized agent after 1944, but the documentation supporting this has not been located.

Despite being successfully weaponized during World War II, the United States did not adopt ricin. Being a delayed-action non-persistent lung agent, it offered little tactical advantage over existing agents. Its higher potency made it marginally better, but it was surpassed by the even more potent biologicals of the time. The military history of ricin ended without it ever being used on the battlefield.

Contemporary Events

Unlike during World War I and World War II, when today's military researchers work with ricin, they focus on detecting it, protecting the forces from it, and treating its effects. The prospects of the agent being used on the battlefield seem remote; however, it has been used in espionage for assassinations, and would-be terrorists have been caught in the act of acquiring it.

For example, two Bulgarian exiles were attacked in 1978. One, Georgi Markov, lived in London and died from mysterious circumstances. The other, Vladimir Kostov, lived in Paris and survived after doctors removed a small pellet from his back. A laboratory analysis identified the pellet as a carrier for ricin. According to Kostov, the pellet must have been discharged from a dart gun disguised as an umbrella. There may have been at least six assassination attempts by this method.[13]

Today there are numerous how-to books that claim to provide readers with the methods of obtaining ricin for terrorist uses. There have been cases of people trying to acquire it for use in terrorism. Small quantities (less than a kilogram) have been found in police raids. It does not appear that terrorists are mastering the technology needed to make ricin an effective weapon, but their preoccupation is inherently dangerous.

Endnotes

[1]The military assigned the letter W to ricin during World War II.

[2]Herman Stillmark, *"Ueber Rizin, ein giffiges Ferment aus dem Samen von Ricinlis commurris L. und einigen anderen Euphorbiaceen,"* Inaug. Diss Dorpat, 1888.

[3]The military assigned the letters XR after World War II.

[4]R. R. Williams, *Final Report on Ricin, Report #OM347.4*, Offensive Chemical Research Division, Bureau of Mines, American University Experimental Station, Washington, D.C., 30 April 1918.

[5] Traditionally, there has been an ethical distinction between chemical and biological warfare and poisoning. A more complete description of this distinction can be found in a book by R. M. Price, *The Chemical Weapons Taboo,* Cornell University Press, 1997.

[6]At the time, this blindness was probably assumed to be permanent, but contemporary animal experiments note only temporary eye effects.

[7]Personal letter from R. Hunt (Harvard Medical School Department of Pharmacology) to Major C. J. West, 18 March 1919.

[8]These investigations included field trials at the Defense Research Establishment Suffield at Ralston, Alberta (Canada), and did not exceed the development efforts of the United States.

[9]S. M. Whitby, *Biological Warfare Against Crops*, Palgrave Macmillan, 2002, p. 81.

[10]A. C. Cope, J. Dee, and R. K. Cannan, Chapter 12, "Ricin," in B. Renshaw (ed), *Summary Technical Report of Division 9*, Vol. 1, PB 158507-8, National Defense Research Committee, 1946.

[11]D. T. Parker, A. C. Parker, and C. K. Ramachandran, Part 3, "Ricin," in *Joint CB Technical Data Source Book,* Vol. IV, Joint Contact Point Directorate, U.S. Army Dugway Proving Ground, Utah, 1996.

[12]Aerosols were a technical problem that eluded the researchers of World War I.

[13]Joseph D. Douglas, Jr. and Neil C. Livingston, *America the Vulnerable: The Threat of Chemical and Biological Warfare,* Lexington Books, Lexington, Massachusetts, 1987, pp. 84-85.