

Testing for Trichinosis

A new serological test should make it quick and easy to detect trichinosis in meat—a feat of no small economic importance

A delegation from Singapore recently journeyed to Des Moines, Iowa, to speak to the National Pork Producers Council about the possibility of importing U.S. pork. According to David Meisinger of the council, the Americans were in a quandary. Should they even mention trichinosis, the parasitic disease that is frequently found in U.S. pork? Or should they keep quiet about it? Because the United States does not inspect for trichinosis and other countries do, most countries, including those of the Common Market, will not accept our fresh pork. But the pork producers council members need not have worried. The members of the Singapore delegation quickly got to the point. If they do agree to import American pork, they asked, will it be free of trichinosis?

Trichinosis is transmitted by eating the raw or undercooked meat of animals that have the larvae of the roundworm *Trichinella spiralis* in their muscles. When transmitted to humans, the organism produces weakness, swelling, and intense muscle pain, among other symptoms. Symptoms can last for several weeks.

Tests for trichinosis have been available for over 100 years, but, for a variety of political and economic reasons, the United States has chosen not to employ them. The U.S. Department of Agriculture (USDA), however, has been actively supporting research on inexpensive serological tests and now, after nearly 35 years and \$10 million, it looks as if it has one. Many pork producers, says Meisinger, would like to use the test and then label fresh pork "*Trichinella*-safe."

The test is an ELISA, for enzyme-linked immunosorbent assay, and it relies on antibodies that are present in the blood of infected pigs. *Trichinella* antigens coat plastic wells of a test plate and are used to trap antibodies from pig serum. Only pigs that are infected with trichinosis will have these antibodies. According to Dickson Despommier of Columbia University School of Public Health, who isolated the antigens used in the test, the method should cost only pennies per pig and, so far, it is completely accurate.

The trick to developing this test was to isolate the proper *Trichinella* antigens. After the USDA and its contractors at Los Alamos National Laboratory spent close to 8 years trying to make an ELISA

work, they contacted Despommier for help in obtaining antigens which come from the *Trichinella* larvae. When they burrow into cells lining the small intestine, the larvae secrete about 20 antigens. To isolate these antigens from the hundreds to thousands of *Trichinella* proteins, Despommier infected rabbits with *Trichinella*. He used these rabbits as a source of *Trichinella* antibodies and then used the rabbit antibodies to trap the *Trichinella* antigens.

To test the new trichinosis detection system, the USDA took serum from 1300 Puerto Rican pigs. (There is no trichinosis in Puerto Rico.) All the serum samples tested negative. Then they tested pigs that were purposely infected. All tested positive after day 24 of the infection. However, says Despommier, "that's okay because larvae from infections that are only 24 days old are, for the most part, not infectious for another animal." And, Despommier adds, "from day 24 on, even pigs infected with the lowest doses of larvae tested positive."

The USDA also tested the system on

cooked meat of almost any carnivore. For example, members of an arctic expedition at the turn of the century died when they ate raw *Trichinella*-infested polar bear meat.

Trichinosis is not a serious health problem in the United States, but it does cause several deaths a year in this country and 60 cases were reported to the Centers for Disease Control (CDC) in 1984. About 4 percent of Americans harbor *Trichinella* worms in their muscles, although most were never diagnosed as having trichinosis. The trichinosis incidence, says Peter Shantz of the CDC, was established by surveys of diaphragmatic muscle obtained on autopsy. It is estimated that only 1 in 1000 to 1 in 3000 trichinosis cases is ever diagnosed.

Most people who develop trichinosis attribute their symptoms to flu. There are no effective serological tests to detect the disease in its early stages when it can be treated. The newly developed USDA test, however, may well be useful for diagnosis in humans as well as in pigs.

Looking for trichinosis

Women inspect fresh pork at a meat-packing plant in Chicago in 1896.



pigs from farms in the southeastern United States where there is a high incidence of trichinosis. Every pig that tested positive with an older and established test using pepsin digestion of the meat was also positive with the ELISA. Finally, Robert Eisenstein of the USDA and his associates gave identical serum samples to four regional USDA laboratories. All came up with essentially identical results using the ELISA, thereby validating the test.

Most people who develop trichinosis get it from eating raw or undercooked pork that is infested with the larvae of *Trichinella spiralis*. Pigs are among the few carnivores that people eat and so are the chief source of trichinosis. But every mammal is susceptible to the disease and it can be transmitted by eating the under-

But the main value of the new test is economic. According to Meisinger, it is estimated that the export market for U.S. pork will increase by one-third if the pork is certifiably *Trichinella*-free and that domestic demand will increase by 2 percent for a total return of \$449 million in the first year of testing.

The new test for trichinosis comes, appropriately, just in time to mark the 150th anniversary of the discovery of *Trichinella spiralis* by James Paget, who was then a first-year medical student at St. Bartholomew's Hospital in London. On 2 February 1835, Paget was dissecting a cadaver and saw small white specks in its flesh. He examined them with a microscope and saw that they consisted of cysts with small worms inside. Al-

(Continued on page 624)

(Continued from page 621)

though the white specks had frequently been observed by others, it was assumed that they were flakes of bone.

Yet it was not until 1859 that the first clinical case of trichinosis was recognized. As *Trichinella* historian William C. Campbell of the Merck Institute for Therapeutic Research in Rahway, New Jersey, tells the story, it was Christmas-time in Germany and a young servant girl who was preparing meats for the holiday meals became ill. She was tired, dizzy, had a fever, and—tellingly—suffered from excruciating muscle pain. Early in the new year, she was brought to the hospital in Dresden where the pathologist, Friedrich Albert von Zenker, diagnosed her as having typhoid.

The servant girl did not do well. She lay curled up in such pain that she could

barely move. Fifteen days after she entered the hospital, she died. Zenker, who wanted to examine her muscle as part of his postmortem confirmation of her typhoid infection, removed a sliver of muscle from her arm, crushed it, and examined it under a microscope. What he saw amazed him. There were dozens of tiny worms wriggling in the muscle. He went on to examine other muscle tissue from the young woman and, in every case, he saw the worms.

Once trichinosis was recognized as a disease, European investigators began recording dramatic outbreaks, one of which afflicted 8491 persons in Germany alone between the years 1860 and 1880. In response, Germany and most of the countries of western Europe began examining pork before it was sold with “trichinoscopes”—microscopic exami-

nation of pork diaphragm muscle.

In time, some countries also began using another method in which samples of pork muscle are digested with acidified pepsin, which releases the *Trichinella* from them. This method is less tedious than the trichinoscope method, but it has the disadvantages of being slow and of using pooled muscle samples so it can be difficult to trace which pig in the group had the trichinosis.

The United States did not at first examine its pork for *Trichinella* and the Europeans argued that they could not accept uninspected U.S. pork. In 1891, the United States began inspecting pork to be exported but not pork to be sold domestically. But the Europeans enacted other protective measures to keep American pork from flooding their markets and, in 1906, the United States ceased its inspection program. One reason was that the process was expensive. In Germany, the inspection system at the turn of the century involved 100,000 inspectors and cost more than the entire budget for the USDA. In this country, inspections added 64¢ to the cost of each pound of pork in 1894. Another reason for stopping the trichinoscopy was that it was not entirely effective.

Nonetheless, trichinosis inspections in Europe, and particularly in Germany, were effective in stemming the disease. According to Campbell, the incidence of trichinosis in swine in the United States in 1970 was higher than the incidence in Germany in 1870.

For the National Pork Producers Council, timing of the use of ELISA could not have been better. Three years ago, the council resolved to make U.S. pork trichinosis-free by 1987. Not only would other countries buy our fresh pork, says Meisinger of the council, but American consumers may at last learn to cook it properly. “When we tell people to cook pork to 170° internal temperature, that has a huge safety factor and still leaves the pork juicy and flavorful,” Meisinger says.

The USDA is now in the process of screening 12,000 serum samples from the slaughterhouses to get an idea of how prevalent trichinosis is in this country. And there is no reason why the same test system—with different antigens—could not be used to test for other infectious diseases of animals, says Jack Leighty of the USDA in Beltsville, Maryland. One reason there are no laws requiring that meat be inspected for infectious diseases is that there were no good test systems, according to Leighty. Now, with ELISA that situation could change.

—GINA KOLATA

Zeta Particle in Question

Last July, high-energy physicists were surprised and excited by the news that a completely unexpected elementary particle, tentatively dubbed the zeta, had been uncovered by a group of American and European researchers working at the German Electron Synchrotron (DESY) laboratory in Hamburg (*Science*, 31 August 1984, p. 912). Now it seems the once brash zeta has turned shy.

Although it will take some months to know for sure what happened, the evidence for the zeta was considerably weakened by the particle's failure to show up in a second experimental run. A third run anytime soon is said to be problematical. One disappointed theorist's assessment of the prospects for the zeta's existence: “People don't have high expectations.”

The putative zeta turned up in an experiment by the international Crystal Ball collaboration, whose U.S. spokesman is Elliott Bloom of the Stanford Linear Accelerator Center. The Crystal Ball detector looked at gamma rays given off by decaying upsilons particles, which in turn are produced when beams of electrons and positrons collide head on. According to the experimenters, about 5 times in 1000 the decaying upsilons gave off gamma rays having an energy indicating that the decay product was a new particle, the zeta.

Theorists were immediately captivated. The mass of the zeta and the rate at which it was produced were not consistent with the so-called Standard Model of elementary particles (a melding of two quantum field theories of the forces between particles), which made the zeta just strange enough to be interesting but not too bizarre. And the experimental evidence, a signal 5 standard deviations above the background, was convincing.

Last fall, there was a second experimental run of about twice the total number of electron-positron collisions (integrated luminosity in the jargon) as the first. In the half of the data that has been examined, the Crystal Ball detected no zeta's. There was even a slight dip in the number of gamma rays at the expected energy. A second collaboration experimenting at a Cornell University accelerator, although not working under conditions optimized for zeta searching, has also failed to confirm its existence. With the analysis only partially completed, the Cornell group now estimates that decays to zeta-like states occur less than about 1.5 times in 1000, if at all.

Despite the widespread skepticism, there is a way to save the zeta: its signal could be real but smaller than the first Crystal Ball results suggested and Cornell can presently measure. Until the original data are explained, the zeta is down but not yet out.—ARTHUR L. ROBINSON