A Listeria Primer

Listeria are rod-shaped bacteria common to our environment. One species, Listeria monocytogenes, can cause listeriosis, a disease that can be serious for some people over 60, newborns, pregnant women and those with compromised immune systems. Healthy people do not often develop symptoms after eating food contaminated with L. monocytogenes. Even for people at risk, symptoms may be limited to flu-like fever and nausea. However, more serious cases of listeriosis may result in meningitis, septicemia, central nervous system complications, inflammation of the lining of the heart or miscarriage in pregnant women.

Smoked Fish Industry: Using DNA Fingerprinting to Improve Safety

Bright coral-colored smoked salmon, glistening white smoked sable and tempting whitefish salad are delicacies found in gourmet shops all around the New York metro area. In fact, smoked fish and New York go together like—well, like bagels and lox. But in recent years government regulators have found the need to control a possible harmful pathogen that can occasionally be found in fish products as well as other foods such as soft cheeses. Its name is Listeria monocytogenes, and this common bacteria can sometimes harm people with compromised immune systems—elderly, newborns, pregnant women and persons with AIDS. The government answer to this potential danger has been to have a zero tolerance for the pathogen in ready-to-eat foods in order to assure consumers that they are buying and eating safe products. However, Martin Wiedmann, a researcher from Cornell’s Food Science Laboratory has reason to think that only a fraction of the organisms classified as Listeria monocytogenes are actually responsible for human disease. Most other types may be harmless or at the worst affect only animal species or perhaps fish. The only way to find out which bacteria are likely to be found in fish products is to actually visit processing plants, take samples along each step of the way and then identify the bacteria that are found with the latest DNA fingerprinting technology, a project he and doctoral student Dawn-Marie Norton are conducting with funding from New York Sea Grant.

"This is a very good example of NYSG’s abilities to work with industry to examine potential problems," says NYSG Director Jack S. Mattice. "Because of NYSG’s reputation as an objective information provider, the results are more likely to influence agency policy."
According to Wiedmann, of the 13 different types of the bacteria, only three types cause 89 to 96 percent of the human cases of listeriosis. The other ten types have never or rarely been linked to human disease. However, in regulations of facilities that handle smoked fish, there is a zero tolerance for all L. monocytogenes, even those that are naturally found in fish and that may not be harmful to humans. This research may shed light on the need for zero tolerance for L. monocytogenes. The smoked fish industry, which is subject to zero tolerance policy but has not been the source of any significant human illness, might be saved the financial loss of recalled product if the policy can be relaxed based on solid scientific information.

On a recent visit to smoked fish factories, Wiedmann asked Sea Grant staff to tag along to observe the process. So on a scorcher of an August day, the group set off to visit two such plants located in Brooklyn. The first, Service Smoked Fish, has been a family business for over 60 years and Jay Weiner, the present owner and operator, notes that they’ve been processing smoked fish for the last 20 specializing in salmon, smoked trout and chubs. The 20 or so employees start off with an early day working from 4 am preparing daily orders.

The entire process generally starts out with frozen fish which may be from Chile, Alaska, the Baltic or Scotland that has been trucked in from cold storage warehouses in the wee hours. Weiner walked us through each stage: thawing, filleting, brining, drying, heating, smoking and packaging of the finished smoked product. After thawing in tanks so that conditions stay tough for bacteria, the fish are filleted and placed in brine in a refrigerated room for up to a week. The salt and sugar in the brine are added by strict formula. If the room deviates from its cold temperature an alarm sounds in Weiner’s office. Once the fish are removed from brine they may be placed in ovens to be dried and smoked.

“Getting just the right texture requires careful control, especially of the temperature,” Weiner tells us as our own internal thermostats adjust to the increase of over 50 degrees near the ovens. We learned that smoked fish is either “cold” smoked or “hot” smoked with cold smoking taking a longer time with temperatures of only between 78 and 80 degrees Fahrenheit. Smoke is added for just part of the time. “A little goes a long way,” comments Weiner. In walk-in ovens, smoke from smoldering wet sawdust of maple, hickory or cherry is circulated throughout. Here, high tech meets low tech. Temperature control and smoking times are monitored by digital readout, but the smoking is a pretty basic, ancient process.

Along our route, Wiedmann and Norton are getting samples, trying to find out the possible source of L. monocytogenes. Is it from the raw material—the fish itself? Is it in the brine, on the cutting boards or slicers? Another part of their study is to determine exactly which type of L. monocytogenes may be found in each sample. Will it be one of the three types of the bacteria that causes listeriosis or one of the ten types that have never or rarely been linked to human disease?

As Wiedmann and Norton leave Service Smoked Fish they carefully place the samples in coolers. Once back at the lab, each sample will be tested for the L. monocytogenes bacteria using culture and DNA-based methods developed by Qualicon, Incorporated.

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Each confirmed \textit{L. monocytogenes} isolate will be further classified using a DNA fingerprinting method. This analysis allows isolates to be grouped with other \textit{L. monocytogenes} with the same fingerprint. According to Wiedmann, “We have a database of 153 human listeriosis case isolates which enables us to determine how often a given fingerprint group has been found in human listeriosis cases.” This team is able to determine within 48 hours exactly which type of \textit{L. monocytogenes} is present in a sample — if they find any.

Around noon at Acme Fish Corporation, there is a hum and a buzz as 145 employees produce the company’s 125 different fish products. Acme, operating since the early 1900’s, started with very traditional smoked fish products and has branched out to include more novel products. According to Frank Costanzo, Director of Quality Assurance and Research & Development, Acme goes through about 5 million pounds of salmon annually. On this visit, the investigators are taking about 30 samples. They follow the same type of fish in its processing from raw to finished product. For example, as workers unload a hefty box of frozen salmon from Norway into thawing tanks, Wiedmann and Norton decide they’ll sample Norwegian salmon when its frozen, brined, then smoked in the final product. They might take samples of the raw iced whitefish from the Great Lakes and then sample the smoked whitefish salad. They also take samples from the cutting table, drains, skinners, slicers, deboners and even the condensation from the pipes above the thaw tanks. The investigators are doing a sampling job worthy of an inspection, but their science is a little more specific. The results? Acme, like Service Smoked Fish is doing an excellent job of meeting standards.

In an earlier visit to a smoked fish plant, the investigators isolated the bacteria from the drain in the raw materials cutting and brining room. “This was not surprising as the processing environment often serves as a source of this organism and other bacterial contaminants,” wrote Wiedmann is his report. Continuing to rigorously clean and sanitize this area as well as monitoring the thawing process helps minimize the risk of a final product having \textit{L. monocytogenes} contamination from this potential source. However, in this instance, the DNA fingerprint results showed that the percentage of bacteria of this type associated with human disease is a low 5.2 percent. This example gives further credence to Wiedmann’s hypothesis that of the few occurrences of \textit{L. monocytogenes} found in smoked fish plants, DNA fingerprinting reveals that only a fraction of them are actually harmful types in humans.

Back on our Acme tour, Frank Costanzo explained how “some fish, like whitefish are hung where drying is key. The skin gets rigid and the protein denatures. It’s smoked for one to two hours, then cooked to a required temperature.” The filets, however, like the bright beautiful orange Norwegian salmon are placed on racks, wheeled on hand trucks, dried and then smoked. Costanzo walks us into the largest cold-smoking room at Acme, and perhaps the country. Its two levels sport hand trucks full of the delicacy.

\begin{quotation}
Only three strains cause 89-96\% of the human cases of listeriosis. Ten strains have never or rarely been linked to human disease.
\end{quotation}

In the packaging room amid sparkling tile walls, men in hats and women with hairnets are using pneumatic slicers and specialized curved electric knives for removing the center portion of the salmon. Out the door, shippers are wrapping boxes ready to be loaded on trucks. Depending on traffic they can make it to shops by lunchtime. \textit{Bon appetit.}

— Barbara Branca