Meat and Meat Products

Half a century of meat research, primarily at the Eastern center, has focused on improving the flavor, nutrition, tenderness, and safety of meat and meat products. The pursuit of these goals has led to many changes in meat product processing and several new procedures to delay deterioration in quality.

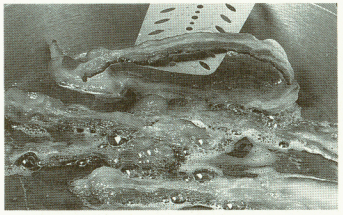
In 1946, the Department of Defense asked ERRC to undertake experiments on the production of canned bacon—a product untreated by heat—that would have a stable shelf life of at least 3 months at 100° F. The other specification was that it would have to smell and taste as good as conventional bacon.

The first step was to find out why all previous attempts to can bacon had failed. ERRC researchers found that the cause of spoilage was the production of carbon dioxide by bacteria known as *micrococci*. Their presence in bacon was normal and expected; it was suspected that they actually enhanced the flavor of bacon. When the bacon was enclosed in a sealed can, however, the *micrococci* produced enough carbon dioxide to swell the cans.

The problem was circumvented by partially dehydrating the bacon during smoking until the ratio of moisture to salt was decreased to five to one. This single change in processing inhibited the growth of the bacteria and provided the stability required by the military. The discovery has been used extensively by U.S. processors to supply the armed forces.

In 1961, another surprisingly low-cost research project at the Eastern center enabled meatpackers to produce more uniform luncheon meats in a more economical manner. When the research began, U.S. packers had adopted computerized formulas for making various sausages that took into account the price and availability of ingredients on any particular day. A shortcoming of the system was the lack of any simple

Intensive study by ERRC scientists of the mechanism of nitrosamine formation in bacon helped avert a proposed ban on this favorite among breakfast meats.



method for determining the ability of meat ingredients to emulsify fat in making bologna, frankfurters, and the like.

ERRC scientists invented a simple test for measuring the emulsifying capacity of a given sample of meat. It produced a numerical value for each sample that could be cranked into the computerized formula. When ERRC demonstrated to meatpackers that the test could be performed by a nonchemist with a minimum of laboratory equipment, it was quickly adopted by industry.

ERRC meat researchers have studied every aspect of meat preservation and quality, asking and finding answers to tough questions. Why does frozen pork turn rancid after a few months in storage? How safe and reliable is the typical farm-cured ham? What proteins make the best binders for fat in making frankfurters? Exactly what happens to meat, from the chemist's point of view, when it is cooked?

That last question led to one of ERRC's most important research projects—one that probably saved an industry. In the mid-1960's, it had been reported that sodium nitrite, an inorganic compound used to cure meat products like frankfurters and bacon, could, under certain conditions, form nitrosamines, compounds known to be carcinogenic. With the aid of highly sensitive analytical instruments, one of these compounds, DMNA (dimethyl nitrosamine) was discovered in extremely small amounts in frankfurters. Another, known as NPyr (nitrosopyrrolidine), was found to occur in minute amounts in bacon after frying at high temperatures. It was the hot frying that did it; the carcinogen was not found in raw bacon at all.

When the results were made public, consumer organizations called for a ban on nitrites in food and a similar ban on sales of bacon. ERRC responded with an intensive investigation of all aspects of the mechanism of nitrosamine formation, bacon processing, and methods of cooking bacon at home. Searching for nitrite substitutes, researchers tried 500 compounds of various sorts as curing agents; 50 of them were active enough as anti-microbial agents in the test tube to warrant testing them in a meat system. Unfortunately, none worked as well as nitrite in retarding the growth of microbes. But researchers also found that vitamins C and E reduced the levels of nitrosamines in fried bacon and in nitrite-cured products. The research led to changes in Federal regulations and industry processing to minimize consumer exposure to nitrosamines. As a result, the proposed ban on bacon was averted, saving hog producers more than $1 billion a year and keeping one of America's favorite breakfast meats on the menu.

Eastern center scientists also studied the source of flavor differences in beef, pork, lamb, and veal and found out what happened to meat chemically when it was aged in storage. They analyzed a traditional Pennsylvania Dutch product, made for years not far from Philadelphia, called Lebanon bologna. They found that it was not the use of old barrels for aging the meat that gave the bologna its distinctive flavor, as even its processors had supposed, but the amount of salt with which the meat is aged.

A scientist's question in the 1980's about processing fermented meats, like pepperoni and Genoa salami, led to a change in making those products. He wondered why most processors didn't use a starter culture to begin fermentation; more than half of them simply relied on the presence of the right kind of microorganisms through chance contact. But the ERRC researcher found that a bacterial starter culture to produce lactic acid stimulates faster, more consistent fermentation and guarantees a better product. It inhibits the growth of unwanted bacteria that can cause off-flavors or, in some cases, food poisoning.

Other researchers turned their attention to making processed meats, like franks and corned beef, with less salt. More and more in the eighties, high dietary sodium was linked to high blood pressure, heart disease, and kidney failure, and most Americans, nutritionists report, eat five to seven times as much salt as they require. But the high salt level in many processed meats was believed essential as a preservative. ERRC scientists wondered, however, how much salt was really necessary as a preservative.

In the mid-1980's, they reported that just about all processed meats could be made with 20 to 25 percent less salt without the

risk of spoilage. Lower-salt franks, they found, compared well with conventional hotdogs in flavor, texture, and shelf life. They also discovered that proper refrigeration is more important than salt level in retarding the growth of microorganisms that cause spoilage.

Other regional laboratories have also contributed to meat research from time to time. At the Western center, a chemist developed and patented a 1-hour early warning test to detect spoilage in hamburger. It uses a high-performance liquid chromatograph to measure levels of lactic acid in the ground beef; high levels indicate the meat will spoil quickly. The test is a valuable one for firms that buy quantities of ground beef in bulk: fast-food restaurants, supermarkets, and the military.

A highly original invention to make roast beef more palatable was recently patented by the Southern laboratory. It is a chemical, derived from crabshells, which preserves the desirable flavor characteristics of beef in leftovers. It accomplishes this feat by inhibiting the iron that is naturally present in beef from reacting with oxygen in the air. This prevents the polyunsaturated fats from being broken into compounds that cause off-flavors in the meat. The new miracle chemical, N-carboxymethylchitosan (known as NCMC for short), will also prevent off-flavors in other meats, fish, and poultry, according to the SRRC inventor. It can be applied either during food processing or at home, like any other seasoning.

Reduced-sodium frankfurters are manufactured for taste testing in ERRC laboratory by food scientist Richard Whiting (left) and student assistant Charles Kunsch.