How the Art and Science

of Food Preserving

Changed the World

Sue Shephard

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There are numerous chemicals in smoke, including alcohol, acids, phenol, and other phenolic compounds and toxic substances, some of which are now thought to cause cancer. These toxic substances, such as formaldehyde, inhibit the growth of microbes, while the phenols also retard fat oxidation. Smoking is particularly useful for preserving fatty foods such as bacon and herring.

There are two basic methods for smoking that depend on the heat of the smoke. When food is "cold smoked" the temperature is no higher than 29°C (85°F). The smoke permeates the flesh, slightly drying but not cooking it, and creates a mild, smoky flavor. The preservation, however, is only partial, and the meat or fish will only keep for a limited period. Many kinds of cold smoked or lightly smoked foods are eaten raw, such as smoked salmon or smoked fillet of beef.

In "hot smoking" the heat is raised to temperatures over 55°C (130°F), depending on the type of food. This method partially cooks the flesh, which hardens and turns a dark golden or reddish-brown color and produces a more strongly smoked flavor. Beef, venison, game, poultry, smoked trout, and buckling are popular hot-smoked products. Originally smoking was combined with salting and drying, but modern smoke cures contain much less salt and smoke than the old traditional methods and are much lighter smoked for a more delicate flavor. Smoked foods are now more highly valued for their flavor than for their keeping qualities.

In 1821 William Cobbett outlined in his book *Cobbett's Cottage Economy* the traditional home-smoking method, carried out for centuries. He advised that when smoking a flitch of brine-salted bacon, "before smoking lay the fitch on the floor, and scatter the flesh side thickly with bran or sawdust (not deal or fir). Rub it on, and pat it well down upon it. This keeps the smoke from getting into the little openings, and makes a sort of crust to be dried on." When hanging the meat up, "two precautions are necessary: first, to hang the flitches where no rain comes down upon them: second, not to let them be so near the fire as to melt."

To prevent the smoke becoming so hot that the fat melted, the fire had to be well damped down with smouldering sawdust. Cobbett suggests that "stubble or litter might do" to keep it cool enough. Ready access to the right wood was also important. Softwoods such as fir or deal are resinous and can produce a bitter taste. Naturally, in

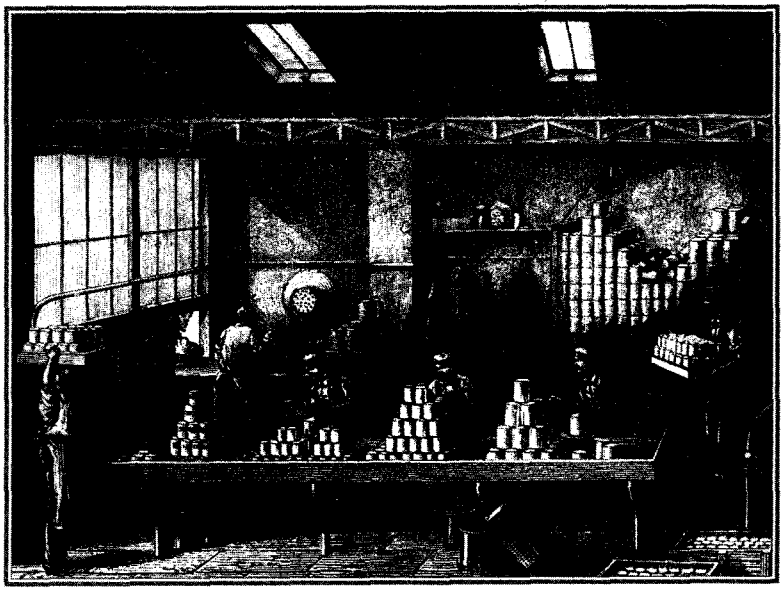
ling in the frying pan. "Now listen there, boy," said his uncle Charlie, "you can hear the squeal if you've got good ears," and he could.

Fish

Around Lake Biskupin in northeast Poland, archaeologists digging in the 1960s discovered a strange kind of ancient settlement. There were forty-three peculiar pear- or bag-shaped holes and sixteen hearths. Professor Z. Rajewski, who discovered the site and dated it to around the ninth century, believed that it was the remains of a sophisticated center for the mass production of smoked fish. At the bottom of the holes were fish bones and scales and the hearths were covered with a thick layer of burnt bones and scales—the remains of fish such as pike, bass, roach, bream, and a very big catfish. Professor Rajewski and his team attempted to smoke some fish using exactly the same techniques that they believed had been used eleven hundred years ago. After scaling and gutting, the fish, which were mainly quite large, were cut up and soaked in brine for two hours. Smoking experts who examined the site decided that the pit was suitable for a hot-smoking process so the fish pieces were first smoke-dried over the open hearths in temperatures of up to 100°C (212°F) and then hung on a rod in the holes over a smoke of oak sticks and green juniper. The holes were covered over with wood planks or a straw roof and left for up to two hours. If left any longer, they found that the fish turned tough and lost their necessary fat. The experiment, using authentic ninth-century equipment, produced some tasty golden-brown smoked fish.

In fact, more primitive methods of smoking than this are still practiced around the world. In many parts of Africa the tradition is for fish to be sun-dried and hard smoked until almost burned. Large oil drums are covered at one end with wire mesh. The fish are laid on the mesh and smoked over a charcoal fire. Wet wood shavings are then scattered over the embers, producing a dense smoke. This kind of hot-smoked fish is called "*bonga.*" Simple smokehouses made from large old barrels or oil drums can be found still in use in many parts of the world.

In medieval Europe vast amounts of salmon were salted and dried,



Filling and soldering cans in a French canning factory, 1870—possibly Chevallier-Appert

would corrode the tin. Each tin lid was fitted with a ring for carrying and for hanging them up. In 1841 calcium chloride (or sodium nitrate) was put in the sterilizing baths, raising the temperature above boiling and greatly reducing the processing time, which often overcooked the food. Another innovation was the practice of continuing to heat the tins after the final sealing. This would have had nothing to do with air extraction but was invaluable in destroying any remaining bacteria and must have been empirically arrived at. Temperature was sometmes not adequately controlled, and there was the occasional accident; one operator was described as having been "killed most ridiculously and ignobly by a boiled turkey." The canister containing the turkey was overheated and burst; "the dead turkey sprang from his coffin of tinplate, and, killing the cook forthwith, made him at once a candidate for a leaden one."

A solution to the problem of exploding tins was to heat them in an enclosed container called a retort or autoclave, using steam under pressure, rather like Papin's seventeenth-century digester and our modern pressure cooker. In 1831 Appert had already designed an autoclave for cooking meat, and his nephew later patented one for pro-

cessing the tins as well. Retorting of tins was known in Britain in the 1830s, and by the 1870s, autoclaves had been developed in America and Britain that successfully remained in use until the end of the nineteenth century.

Tins were produced in a variety of sizes, ranging from the smallest (two pound) to enormous ones weighing nearly seventeen pounds, which must have created huge problems with sterilization. All the finished tins were tested in a chamber for a month, where they were subjected to tropical temperatures to check that they had been properly processed. If they had not, the tins would bulge out at the ends, and in the early days some even exploded. However, this was not a very sound method, as some bacteria could not have been detected by this means.

Opening these tins presented quite a challenge. Most early tins were sold as military supplies, and until the 1840s the instructions on tins called for the use of a hammer and chisel. The earliest domestic openers were made in the 1860s and were called Bull's Head tin openers, as they had a cast-iron handle shaped into a bull's head and tail and were sold with tins of bully beef. It could be a violent and messy business. The unfortunate Lady Mary Hodgson, caught up in the siege of Kumasi in west Africa in 1900, was trying to remain calm as she cut up tinned bologna sausage: "It was the last one of our stores, and had been saved up for this dreaded but expected moment. The sausage was in a tin which had in the hurry been badly opened, and it would not allow itself to be pushed out; the poor thing had a great wound in its side from the tin-opener, and every time I attempted to cut off a slice the sausage would recede."

Nowadays, canned food production is most often associated with the United States, but it was an English immigrant, William Underwood, who first introduced canning to America when he arrived there in 1817. He had worked in the pickling business in England and started preserving "after the manner of Appert" when he opened a factory in Boston. There he first bottled and later canned lobster and salmon, which he exported using the label "Made In England," presumably to make the consumer feel it was a well-tried safe product from the old country and not something suspect from the "new." It was Underwood's bookkeepers who first used the word "can." In 1819, another English immigrant, Thomas Kensett, also started by preserving

oysters and other seafood, first in glass jars and later in handmade "vessels of tin." By 1825, Kensett, together with another canner, Ezra Daggett, had established a thriving cannery in Baltimore. Only eight years after taking out his first controversial English patent, Peter Durand resurfaced in America, where he took out another patent for the same process; whether Appert was also part of this venture is not known.

America was initially slow to develop technical advances, but the enormous success with fish canning soon resulted in a rash of factories springing up along both eastern and western coasts, and progress speeded up. The American Civil War in 1861 created the first major demand for American canned food, especially pork and beans, condensed milk, oysters, and green beans for the Union troops, and a meat and vegetable stew known as "burgoo" for the Confederates in the South, where there was widespread hunger. Despite the army sutlers reporting that the men preferred French canned sardines, salmon, and peas, hundreds of soldiers returned to their homes with praise for this dependable, portable, and storable food. Cans of corn, baked beans, hominy, pumpkins, sweet potatoes, succotash, and sea kale were soon filling shelves in the home and appearing at table in all kinds of dishes. With the newly built railroads, food producers were quick to seize on a new way of safely moving huge quantities of meat, fruits, and vegetables produced in abundance and canned in one state to other states thousands of miles away where there might be shortages.

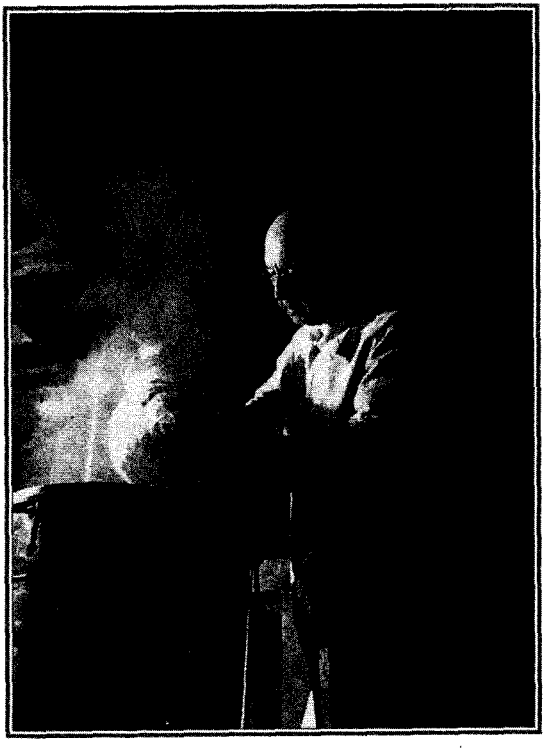
In 1849 a new machine for food canning was invented to make the tops and bases of the cans; this enabled two unskilled workers to produce as many as fifteen hundred cans per day. By 1865 improvements in canning production included the manufacture of cans made of thinner steel with a rim around the top of each can, which led to can openers being developed instead of the hammer and chisel. In 1866 a special can with its own key opener was introduced. By the turn of the century, America had succeeded in mechanizing both the manufacture of cans and the canning process, and the country had leaped to the front of the world canning industry. Europe and Britain imported vast quantities of U.S. Pacific canned salmon, and salmon canneries appeared at the mouth of almost every river as far north as Alaska. The cans were given a final coating of a mixture of red lead,

turpentine, and linseed oil. The resulting fiery red color came to be associated with red salmon, and some canned salmon today still has the characteristic red label.

By the 1870s America was packing more different kinds of food in far larger quantities than any other country. Canning in the United States revolutionized the way people ate and cooked, leading the way to all kinds of factory-processed and -packaged foods. James Collins in *The Story of Canned Foods* wrote: "Canning gives the American family—especially in cities and factory towns—a kitchen garden where all good things grow, and where it is always harvest time. There are more tomatoes in a ten-cent can than could be bought in city markets for that sum when tomatoes are at their cheapest, and this is true of most other tinned foods. A regular Arabian Nights garden, where raspberries, apricots, olives, and pineapples, always ripe, grow side by side with peas, pumpkins, and spinach; a garden with baked beans, vines and spaghetti bushes, and sauerkraut bed, and great cauldrons of hot soups, and through it running a branch of the ocean in which one can catch salmon, lobsters, crabs and shrimp, and dig oysters and clams."

The first settlers to arrive at Sydney Cove in Australia in 1788 were provisioned for their long sea journey with salt beef, salt pork, flour, pease, ship's biscuit, butter, and rice. They had no idea that they would have to live on these for many years, until the unyielding land, lack of water, and harsh conditions that they first found were finally made to produce some fresh food. They had to rely on imported salt meat, and so that they could start salting their own meat, they had to recover the salt from bought salt meat. Later, the settlers made a bitter salt from boiled sea water, which they could use to salt meat and fish and for curing seal skins. But at that time there was not enough meat to preserve, and so in 1801 shiploads of salt were sent to Tahiti, where their plentiful pork was salted into barrels, and over the next twenty years thousands of tons of salt meat was imported into Sydney. By the 1820s, however, Australia had its own large herds of sheep and cattle that supplied a now thriving trade in salt meat, much of which was sent back to England.

Dr. Keith Farrer, in his book *A Settlement Amply Supplied,* about



Clarence Birdseye experimenting in his workshop in the 1920s

in commercial quantities. His fascination with the idea of food freezing was not only avid, but wide ranging. There was not a frozen food item that he did not experiment with. He tried all kinds of foods, including baked goods and even complete cooked dishes, always tasting everything himself. He built a double-belt contact freezer, in which the food was frozen on two sides simultaneously, using two hollow metallic belts filled with cold brine. After that, he made multiplate freezers and mounted them on trucks to make mobile machines to freeze vegetables as soon as they were picked.

But commercial success still proved elusive. His was a small concern and he was a cut-and-try experimenter on a small scale. He had faced many obstacles, much resistance, and numerous discouragements. But it never occurred to him to lose faith in the soundness and

cially loved to go fishing in his power launch the *Sealoafer* and to go out with his gun and his dogs. Birdseye also continued to experiment and design, producing an efficient fish-filleting machine, a reflector and infrared heat lamps, and a kickless harpoon gun for hunting whales. He was fascinated by hydroponic farming and believed that it would be possible to grow enough food on the rooftops and in the cellars of New York City to provide three square meals a day for "every inhabitant of that immense city."

But the cautious inhabitants of New York and the rest of America took some persuading before they would embrace frozen food, let alone anything more futuristic. One of the major early problems in inducing people to accept quick-frozen foods was a widespread aversion to "cold storage" foods, which were often associated with unpredictable off-flavors and inferior quality generally. General Foods soon launched the term "frosted foods" to suggest something new and improved. How, they wondered, could you convince the conservative housewife that quick-frozen food can be entirely fresh, even though it is frozen hard as marble? And while the consumer was cautious, the retail food shop was even less enthusiastic about paying out capital for a freezer cabinet in which to display these dubious wares.

In Springfield, Massachusetts, there was one grocer who, with ten others, was prepared to be a "missionary" to convert an eating public that had been brought up on fresh and canned foods. On March 6, 1930, Joshua Davidson first opened his new freezer cabinet, designed by Birdseye, supplied by General Foods, and filled with an alluring range of "frosted foods." On offer were June peas and spinach, frozen raspberries, loganberries, and Oregon Bing cherries with their stalks on, plus a "really superb selection of prime meat and fish products." This became the "miracle" that produced fresh foods out of season and changed eating habits so radically that there are generations today who no longer know what fresh peas in the pod taste like; indeed, they might not even like them. Frozen peas are processed far nearer to picking than the fresh pea can be bought in the shop. Even when frozen, the enzymes continue to slowly produce sugar from starch, which makes frozen peas much sweeter than fresh.

In an article in the trade magazine *Quick Frozen Foods* published thirty years later, the grocer Davidson recalled, "The food customer of 1930 was prejudiced against frozen foods. She felt foods were

until the nineteenth century. Made from the unfermented acidic juice of unripe grapes or apples, verjuice was used in the same way as vinegar, and its milder flavor made it popular in many parts. It could also be distilled and stored for later use. Alegar was another mild vinegar made from sour ale or malt. Wine vinegar, however, was always regarded as the ideal for pickling, as it was said to have the best flavor.

Vinegar pickling of all kinds of food suddenly became very popular in the sixteenth century in England, when salted foods were losing favor and were gradually being relegated to the food of the poor. When the English farmer's wife had a glut of eggs, she would boil them hard, shell them, and pile them into earthenware or glass jars and pour over them scalding vinegar well seasoned with pepper, ginger, garlic, and allspice. "The eggs are fit to use after a month" and were quite a treat in the farmhouse kitchen. Similarly pickled were the small, firm "top" onions, which were the best for the job. Where walnuts were common, the still-green nuts were gathered in July for pickling. An eighteenth-century English recipe directs that the walnuts should first be left to lie in strong brine for a week until they turn black (unless the moisture is first drawn out, it would end up diluting the vinegar and cause the pickle to ferment). After washing the salt off, the walnuts are packed into a jar with whole cloves of garlic, peppercorns, and a few cloves. Some vinegar, spiced with nutmeg, Jamaica pepper, and allspice, is boiled up and poured over them. They are left to stand overnight, when the process is repeated. The jars are finally closely covered and tied down.

Jars for vinegar pickles had to be made from stoneware or glass. Because vinegar is so acidic, it would have dissolved the lead from the glaze of earthenware and poisoned the pickle. Coverings, too, were important and careful corking, tying with bladders, or sealing with wax or resin all needed vigilant handling.

Other nuts, mushrooms, fruits, and vegetables can all be pickled in the same way as the walnuts. The variations are in the raw materials and in the flavoring of the pickle. Adding sugar or honey produces a more mellow or sweet-sour pickle, and adding spices gives it a stronger, additional piquant flavor. Some vegetables need blanching before pickling; others are cooked in the vinegar itself; and some need no cooking. By happy chance it was realized that the repeated pouring of boiling vinegar over vegetables not only preserved them better but also made

spoonfuls of a rich conserve of crunchy nuts, grapes, and sliced lemon bottled up in brandy and sugar.

Preserving food in oils is another ancient custom, popular in ancient Egypt, Greece, and Rome. Oils do not possess natural preserving qualities, but they are a useful alternative to animal fats in hot countries where the fats are liable to melt. There are many different kinds of oil—sesame, sunflower, soya, groundnut, and, of course, olive oil—and their different flavors add to the quality of the preserve. Mushrooms, sun-dried tomatoes, eggplants, artichoke hearts, seafood, and olives are all delicious and look wonderful suspended in large glass bottles of glowing resin-colored oil. The Romans particularly liked balls of soft cheese preserved in jars of oil.

Vinegar and brine are both powerful preservative media, and there is a huge range of pickled vegetables, already described, as well as some fruits such as spiced oranges or plums, hot pickled limes from the Punjab, and salted lemons from North Africa. The strong acidity of vinegar presented considerable problems before glass was widely available, as people used copper and other metal utensils and containers that acid fruits corroded and in which some vegetables turned a nasty green. Glass is an ideal material because it is noncorrosive and can be made heat resistant. Glass jars and bottles of all sorts of shapes, designs, colors, and sizes also make attractive transparent containers, showing off colorful displays of the foods packed inside them.

Food preserving, especially bottling, was essential for the European colonists living thousands of miles from home in difficult climates, surrounded by strange cultures and cuisines. Preserved foods sent out to early colonists were no doubt important contributions to their survival and would also help in their cultural survival, a way of keeping up standards and staying in touch with home. Gradually Western preserving methods were adapted by colonial housewives who taught their servants the fine art of English jam making while using local vegetables and fruits to bottle and pickle some exotic-sounding fare for their tropical larders. Bottling also freed farm families from having to rely on the wooden pickle barrels, root cellars, and smokehouses to get them through the winter. The robust Kilner and Mason jar (introduced in 1858) was fitted with metal

clips, screw tops, and rubber rings to keep the contents airtight. These were enormously popular right up to the mid-twentieth century both in rural and town households for preserving surpluses of fruits and vegetables such as tomatoes, sweet corn, berries, peaches, relishes, and pickles.

It was this process of preserving food in sealed containers or bottles that proved to be the jumping-off point for the preserving revolution to come. The arrival of the airtight glass bottle or jar and the "cooking" of food within it were major turning points in the move from empirical traditions to scientific processes. True to form, it was some time before anyone seemed to have either understood the effects of this process or to have grasped the potential benefits it might have brought.

From its arrival in the West in the sixteenth century until well into the nineteenth century, sugar remained an expensive luxury that even wealthy households kept under lock and key. Preserving fruit as sweetmeats or jams was enormously attractive to the sweet tooth of the rich everywhere, but if fruit could be preserved without sugar . . .

There are some kinds of fruit that are very acidic and require much less sugar or heating to preserve them. The key example is the gooseberry. The earliest known recipe for gooseberry bottling was in *A Book of Receipts according to the Newest methods,* published anonymously in 1680. "Gather gooseberries at their full growth, but not ripe. Top and tail them, and put them into glass bottles, put corks on them but not too close, and sit them on a gentle fire, in a kettle of cold water up to the neck, but wet not the cork, let them stand till they turn white, or begin to crack, and set them till cold, then beat in the corks hard, and pitch them over."

In 1705 William Salmon's popular *The Family Dictionary* gave a number of fruit-bottling recipes, including one for gooseberries. This similarly described heating the bottles, but specified that the corks should be loosely put in the "jars," which were at that time wide-mouthed containers. When the fruit was cooked, the corks were to be knocked further in and sealed. In 1727 Eliza Smith gave an almost identical recipe in her *Compleat Housewife* but used "bottles," meaning they had narrow necks so that only small fruit such as gooseberries and cherries could be pushed through. Richard Bradley in his recipe of the same year advised that the cook should buy spe-

cial wide-mouthed bottles, "Quart Bottles that are made on purpose with large wide Necks." Hannah Glasse's 1747 *The Art of Cookery Made Plain and Easy,* consisting mostly of recipes taken from earlier works, included the same recipe for bottling gooseberries as Eliza Smith and Richard Bradley, who themselves may well have copied theirs from William Salmon. Copying recipes from other authors does not seem to have been regarded as plagiarism in those days; it is not so well tolerated today, though it is still known to happen. The recipe, as it appears in Glasse's book, is this:

> To keep Green Gooseberries till Christmas.
>
> Pick your large green Gooseberries on a dry Day, have ready your Bottles clean and dry, fill the Bottles and cork them, set them in a Kettle of Water up to their Neck, let the Water boil very softly till you find the Gooseberries are coddled, take them out, and put in the rest of the Bottles till all is done; then have ready some Rosin melted in a Pipkin, dip the Necks of the Bottles in, and that will keep all Air from coming in at the Cork, keep them in a cool dry Place, where no Damp is, and they will bake as red as a Cherry. You may keep them without scalding, but then the Skins will not be so tender, nor bake so fine.

This startlingly modern process would not seem out of date to anyone who bottles fruit today. It would have produced a sterile, preserved fruit without the addition of preserving sugar. Yet no one understood the principle nor was able to recognize the importance of the recipe, which sits unremarkably on the page alongside many other fruit recipes, its huge, revolutionary potential unseen for another fifty years.