Who Invented Pasteurization?

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People have a habit of trying to tie inventions to the work of some single genius, but that is not how inventions are created, and not how discoveries are made. This is the first in a series of posts that will examine the process of creation, the nature of the inventive process, and why history inevitably tries to give credit to a single person when inventions are never the result of a single person's work.

Recently I was researching on the medical efficacy of silver as a part of werewolf research, *as one does*. To my surprise I came across a news clipping that was shockingly discordant with my vague understandings of the history of food preservation.

MODE OF PRESERVING MILK FOR LONG VOYAGES

Sir,— As the season of the year is now arrived when hundreds of mechanics are induced to cross the Atlantic in the hope of bettering their fortune and to those who may carry young families with them, milk may be an important article of diet, perhaps the following extract from an old newspaper of the date of 1822 setting forth a simple and easy method of preserving it may be of importance; more particularly as I perceive from your last monthly list of new patents, that a method of preserving animal milk has just been patented whether the same or a different method remains to be seen: —

"Provide a quantity of pint or quart bottles (new ones are perhaps best); they must be perfectly sweet and clean and very dry before they are made use of. Instead of drawing the milk from the cow into the pail as usual, it is to be milked into the bottles. As soon as any of them are filled sufficiently they should be immediately well corked with the very best cork, in order to keep out the external air and fastened tight with packthread or wire, as the corks in bottles which contain cider generally are. Then on the bottom of an iron or copper boiler spread a little straw on that lay a row of the bottles filled with milk, with some straw between each to prevent them from breaking and so on alternately until the boiler has a sufficient quantity in; then fill it up with cold water Heat the water gradually until it begins to boil and as soon as that is perceivable draw the fire. The bottles must remain undisturbed in the boiler until they are quite cool. Then take them out and afterwards pack them in hampers either with straw or sawdust and stow them in the coolest part of the ship. Milk preserved in this way has been taken to the West Indies and back, and at the end of that time was as sweet as when first drawn from the cow.

I am, Sir, yours,
J. Elliott
March 30 1835

This 1835 letter was printed in *The Mechanics' Magazine, Museum, Register, Journal, and Gazette,* Volume 23. In the letter, the author, J. Elliott, writes about a method for preserving milk. He refers to a newspaper article from 1822 (published in 1821, it turns out, then reprinted several times) which cites a detailed method for preserving milk, as well as mentioning a new patent for another method. The method will sound familiar: bottling the milk, sealing it, heating it to a boil, then cooling it. Pasteurization right? Only Pasteur was born in December 1822, which means he couldn't be the inventor of the process for which he is known, could he?

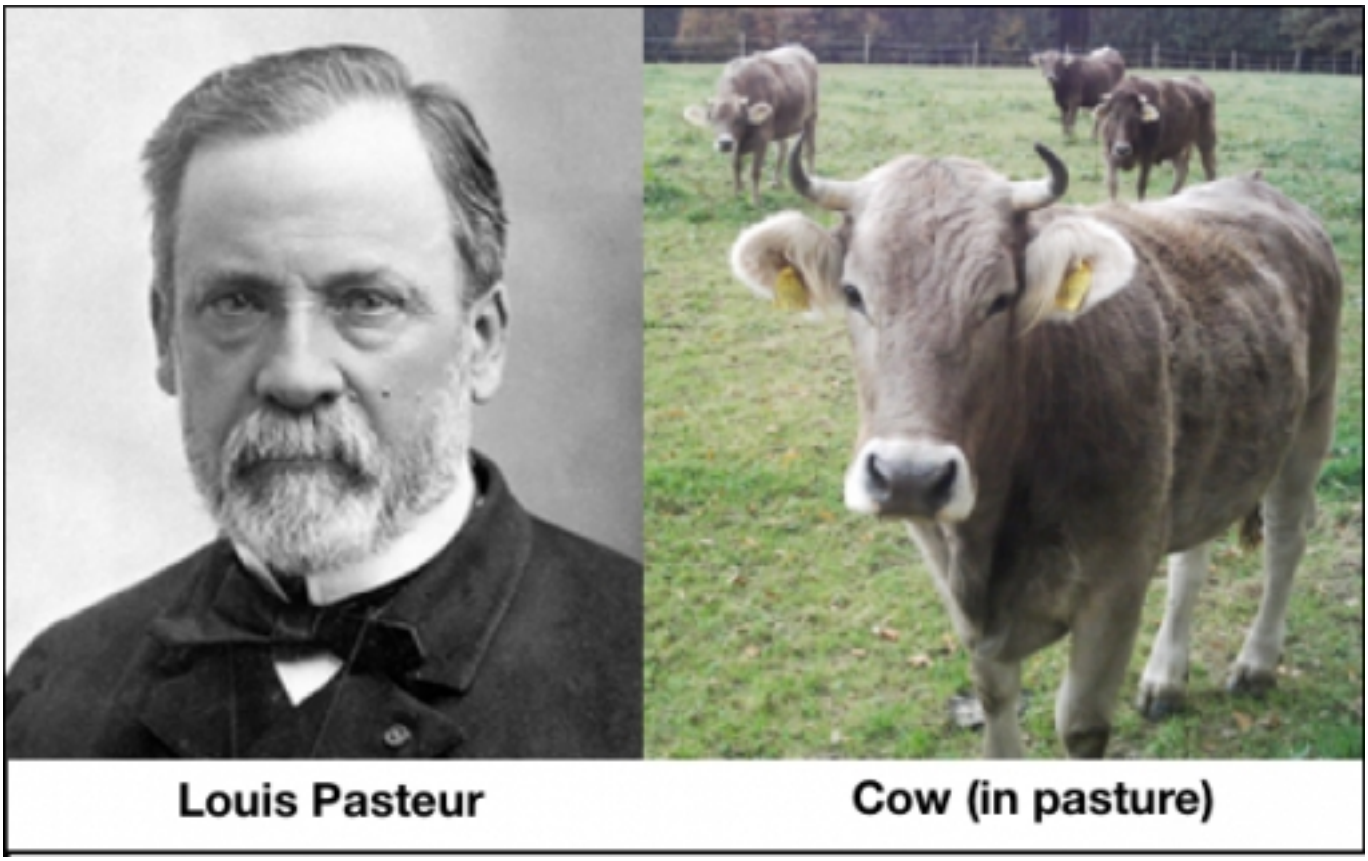
I had to continue my silver research, but I resolved to come back to this topic and figure out who *actually* invented pasteurization. Before we start digging into that question, let's talk about the process Louis Pasteur is so famous for, how it works, and then we'll get into how it came to be known by his name.

Have you ever been to a coffee station and found creamers that said "no refrigeration needed" but that claimed to be cream from a cow? Yet, you buy a gallon of milk from the store and two weeks later it has a horrific smell despite being refrigerated? These items have both been pasteurized—which is to say that they've been heated then cooled to kill off bacteria. It turns out that there are several kinds of pasteurization. The kind used in the US for cold-stored milk is usually High Temperature Short Time (HTST) pasteurization. It is effective in killing off 99.999% of dangerous bacteria. That isn't 100% and over time, even in refrigeration, the milk will go bad. There are also Ultra High Temperature (UHT), Extended Shelf Life (ESL), Microwave Volumetric Heating (MVH), Vat processing and probably even other methods and acronyms.

Some forms of preparation can completely sterilize the milk, allowing it to be shelved safely for months at room temperature. This is why the creamers don't need to be refrigerated. (I still like mine cold because they help make my coffee reach a drinkable temperature faster, but that's not pertinent to this discussion despite its personal significance to my daily drinking habits.)

While reading about pasteurization methods, I came across a lot of discussion about the alleged merits of “raw milk,” which is milk that has not been pasteurized. It surprised me how vociferously some people are promoting the consumption of raw milk—and the rejection of pasteurization as somehow *bad* because it allegedly destroys some of the healthy vitamins. While I can link to research papers that quantify heat’s impact on nutrition, I think it is more important to remind readers of something that I think is underappreciated in discussions of whether to pasteurize or not:
Unpasteurized milk is a disease vector for tuberculosis and other life-threatening diseases.

Yes, before pasteurization became widespread, drinking milk was a common way to catch TB. Until I started researching this topic, I assumed pasteurization was just a way to keep milk on the shelf longer so it could reach my home safely and become a part of a healthy breakfast. I’m not a public relations expert, but I think this should be a more prominent part of some public awareness campaign? This isn’t some kind of “gone with the 1800s” thing either. Raw milk related TB deaths are happening now—in the 21st century—both in America and in Europe .



Louis Pasteur and a cow (in a pasture). Image Rights Info Below.

The story of raw milk enthusiasts is out of scope for this post, but I would encourage you to examine their health claims carefully before adopting their practices. Many of the ideas in the raw milk movement (moovement?) come from Weston A. Price (1870–1948), a dentist who had many interesting ideas about diet, nutrition and cavities. While you won't see "milk" or "dairy" in his Wikipedia page (at the time of *this* article's writing, anyway), his foundation is responsible for the website http://www.realmilk.com, which promotes raw milk as having amazing healthful properties. (It would behoove you to be skeptical.)

Let's get back to Pasteur. You may remember the story of how in the 1860s he performed an experiment involving broth and flasks. He heated the broth in two flasks—one with an S-curve to keep out bacteria and one with a straight neck. He let the flasks cool and the broth in the S-curve stayed fresh while the broth exposed to the air "went bad" as airborne bacteria began to grow in it. Later, he broke off the S-curve and allowed air to enter the "clean" broth. It, too, began to grow bacteria.

Glass flask used by Pasteur, 1860s. If this one was an S-necked flask, that has been broken off. Image Rights Info Below.

It's a compelling experiment. It is commonly used in classrooms to talk about how Pasteur proved the germ theory of medicine. Read just a few excerpts from Pasteur and you'll see that his work had a huge impact on the public recognition that many diseases come from bacteria.

"Having cultivated it a great number of times in a sterile fluid, each culture being started with a minute drop from the preceding, we then demonstrated that the product of the last culture was capable of further development and of acting in the animal tissues by producing anthrax with all its symptoms. Such is—as we believe—the indisputable proof that *anthrax is a bacterial disease."*

— *The Germ Theory and Its Applications to Medicine and Surgery*

"The following days, the blood from the finger remained absolutely sterile: but that obtained from the center of the forming furuncle gave an abundant growth of the same small organism as before."

— *On the Extension of the Germ Theory to the Etiology of Certain Common Diseases*

Pasteur was using the Scientific Method to evaluate germ theory. By the end of his career, he was finding very specific pathogens and identifying the methods of their spread and infection. His work definitively confirmed that many diseases are caused by bacterial agents, and that sanitation was important (especially in medicine) to stop their spread.

But back to that flask experiment. Before Pasteur conducted his broth experiments other scientists had also used the same experiments to argue over the popular theories of *spontaneo us generation*
and
preformationism

. Spontaneous generation is the idea that life could spring from
nothing
into existence, often exemplified by the idea that maggots come from spoiled meat. Preformationism is the idea that grown life comes from tiny versions of the animal adult. It may sound absurd to modern readers, but these theories were subjects of very serious scientific inquiry and their exploration, and the scientific implications of the outcome of such work, had enormous impact on the development of our modern medical practices.

After Dutch inventor and microscope enthusiast Antonie van Leeuwenhoek (1632–1723) discovered spermatozoa in 1677, preformationists were able to divide themselves into camps of *ovists* who believed that the tiny pre-formed human was in the egg and *spermists* who believed it resided in the sperm cells. (Check out the links at the end of this article for a fascinating short video about Leeuwenhoek's impact on the advancement of science. He's one of those historical figures whose work truly changed the way we see the world.)

Before Pasteur's 1862 broth experiment confirmed *spontaneous generation* to be an invalid hypothesis, the same experiment was used to "prove" its validity by John Needham (1713–1781). In 1745 Needham, a scientist and clergyman (and another microscope enthusiast), proposed an experiment to settle the question of spontaneous generation. He made broth in flasks, boiled them and sealed them. Soon microscopic life formed and Needham proclaimed that this demonstrated life is spontaneously created.

The matter wasn't settled though. In 1768, Italian scientist Lazzaro Spallanzani decided to revisit Needham's experiment. He realized there were flaws in the original experiment. Needham hadn't sufficiently heated the broth to kill all the bacteria. So Spallanzani re-created the broth experiment, only he boiled the broth long enough to actually sterilize it. His sealed broth stayed bacteria free as long as the container wasn't opened. When it was unsealed, within a short time the bacteria returned and Spallanzani surmised that there are infectious agents floating *in the air*.

Nearly a century passed between Spallanzani's experiment and Pasteur's. People knew that heating was somehow involved in killing bacteria. Well, a few people did. Keep in mind that the Internet was very primitive in the 1700s and cell phones were still huge bricks that people had to throw through windows in order to make a call. Ideas took longer to spread.

Pasteurization wasn't just a way to delay the spoilage of broth, of course. It had huge

implications for the shelf life of something far more important to most western society: beer and wine. Much of Pasteur's work in food preservation was in these industries. For example, Pasteur conclusively demonstrated that fermentation was caused by yeast in an 1857 scientific paper.

In many ways the late 1800s were a heady time for the beer and wine industries—but they had a problem. Sometimes their products would mysteriously turn sour. Pasteur solved part of the problem by introducing his heating/cooling process.. This had a huge impact on the shelf life because it prevented further growth of yeast (or other unwanted life forms) in the bottles.

A second advancement came through Dr Emil Hansen (1842–1909). Hansen discovered that part of the problem was that only some strains of yeast made good beer. He developed a way to identify, separate and clone the good yeast. Hansen's yeast strains were shared worldwide and are still used today. According to Carlsberg brewery, it was Pasteur's endorsement of Hansen's research that led to their wide adoption of the cloned yeast in the 1880s.

As an aside, it is probably worth researching in another article the impact that beer preservation had on other technologies. Adolphus Busch was the first American to use pasteurization on his beer, in the 1870s. He also influenced the development of mechanical refrigeration, and the development of refrigerated train cars for shipping nationally. The whole history of mechanical refrigeration and heating is a fascinating chain of discoveries that I'll have to come back to later.

Of course, pasteurization is used in preserving other foods. Ever wonder why you can safely leave an unopened mayonnaise jar on the warm pantry shelf for months? Pasteurization. If it says "refrigerate after opening," there is a good chance you're dealing with a product that has been pasteurized: ketchup, mustard, juice, beer, wine, and cans of food. Speaking of cans, did you know the first can opener patented in the US (1858) was invented by Ezra Warner of Waterbury, Connecticut? (Salute!) Priority for the can opener goes to Robert Yates of England in 1855, but both men seem to have developed their inventions separately.

Wait… 1855? That's strange? I mean strange if you consider that placing food in cans and then heating and cooling them for preservation was invented in almost fifty years before the can

opener, way back in 1810, a process patented by Peter Durand of England. Until the can opener was invented, the recommended way of opening a can was a hammer and chisel. As odd as it may seem, the advanced durability of preserved canned food over glass-bottle storage outweighed the inconvenience of having to assault the armored food with steel weaponry before each meal.

As you might imagine, the easy-to-operate, reliable food preservation jars invented by John Landis Mason in 1858 were wildly popular for the home food-preservationist. I still find it surprising that the overall process of pasteurizing food this way is generally known as *canning*, despite most practitioners using jars, but *canning* it is.

The father of tin cans, Peter Durand, was advancing the work of French food preservationist Nicolas Appert (1749–1841). Appert had worked on the problem of food preservation for more than 15 years before writing a book on the process and winning a prize from the Napoleonic government. Appert's method will sound familiar to you by now—he placed the food in a bottle, sealed it, heated it for a period of time then cooled it. But Durand's fame is tied to his patent, and history suggests that it was French inventor Philippe De Girard (1775–1845) who actually developed and first demonstrated the tinned can as a food storage device. Durand sold his British canning patent after a couple of years and it was the buyers who actually setup the first commercial cannery. The success of their commercial cannery was instrumental in the spread the adoption of this new food storage practice. A few years later, Durand would also get a canning patent in the US. Contracts with the British navy also helped ensure canning's success.

Which brings me back to the news clipping which started off this whole inquiry. Being from 1822, it was very likely influenced by the work of Appert and Durand. But what about Pasteur? Why is such food preservation called pasteurization instead of *appertization*? (I'm sure many French soldiers of the time did find the early bottled food more *appertizing* than the fare they had to endure.)

Consider this: Despite the fact that Appert had figured out a way to preserve food, he was not

using a scientific methodology and he didn't know *why* it worked. Early adopters of the canning process made many big mistakes such as not heating the food long enough (which would allow the bacteria to grow in the can leading to ruptured cans in the best case, or sick or dead consumers in the worst) and they sometimes used unsafe lead solder to seal the cans, which famously contributed to
Franklin’s lost expedition
to find the Northwest Passage.

What Pasteur did was to apply scientific rigor and the advances in technology (microscopy, biology, carefully documented repeatable steps, etc.) to the problem. He didn't just figure out *why*
the heating works, but precisely what temperatures, what lifeforms are being killed, and which bacteria are causing specific diseases. Very important work. He did not invent the process, but he quantified it and perfected it.

And I feel I would be remiss in trying to tell the story of pasteurization if i didn't mention the sad tale of Ignaz Semmelweis (1818–1865). In the 1840s Dr. Semmelweis promoted the idea of having doctors wash their hands before attending childbirth. The short version of his story is that he was trying to prevent *childbed fever*, a disease that tended to kill new mothers with alarming frequency. When he implemented his hand washing regimens at his hospital, deaths from this fever dropped to almost nothing. There were cultural and political groups in his contemporary medical society who did not care for his teaching (or, perhaps for Dr. Semmelweis himself?) and ultimately his hand-washing protocols were rejected. He lost his job and eventually ended up in a mental institution where he was beaten to death by his guards after just a couple of weeks. Two years later the research of Dr. Joseph Lister would vindicate Semmelweis's ideas, and it is Lister who becomes immortalized by the general public via the antiseptic mouthwash Listerine and the disease Listeria being named after him. Semmelweis's story is frustrating in that the data supported his conclusions, but the culture couldn't see past their biases.

The history of who invented pasteurization is not simple. While a straight line can be drawn showing the dates of various discoveries and events, it was a meandering process to get to a functional germ theory of disease. Pasteur's meticulous experiments and conclusions are indeed laudable, but his work represents further hard-won progress towards a better understanding of how things work, not the solitary accomplishment of a single determined man.

This is not a unique story in the history of invention and discovery. There is a disconnect between how we are taught history (as a series of names, dates and an accomplishment) that

fails to adequately explain the extraordinary interconnectedness necessary to push the boundaries of human accomplishment forward. Even that perception that we are on some inevitable timeline that starts with the *Flintstones*' stone-wheeled car and ends with *Star Trek* spaceships is, perhaps, somewhat flawed.

Invention is an accretive process. The automobile couldn't exist without all the structural, mechanical and chemical engineering accomplishments that are prerequisites. The digital computer required many mechanical and mathematical discoveries before it could become a reality. And time and time again the claims of primacy of an inventor will be questioned by others who say they've made the same devices. Were they spying? Copying? Or are certain synergies of discovery destined to culminate in nearly simultaneous invention? We'll get to those questions in future posts.

If you're interested in the in these topics, I've linked to my sources below. I would especially commend to you the DVDs by James Burke. His work presents many scientific discoveries in a fascinating and entertaining manner, revealing many ways in which discoveries have surprising connections