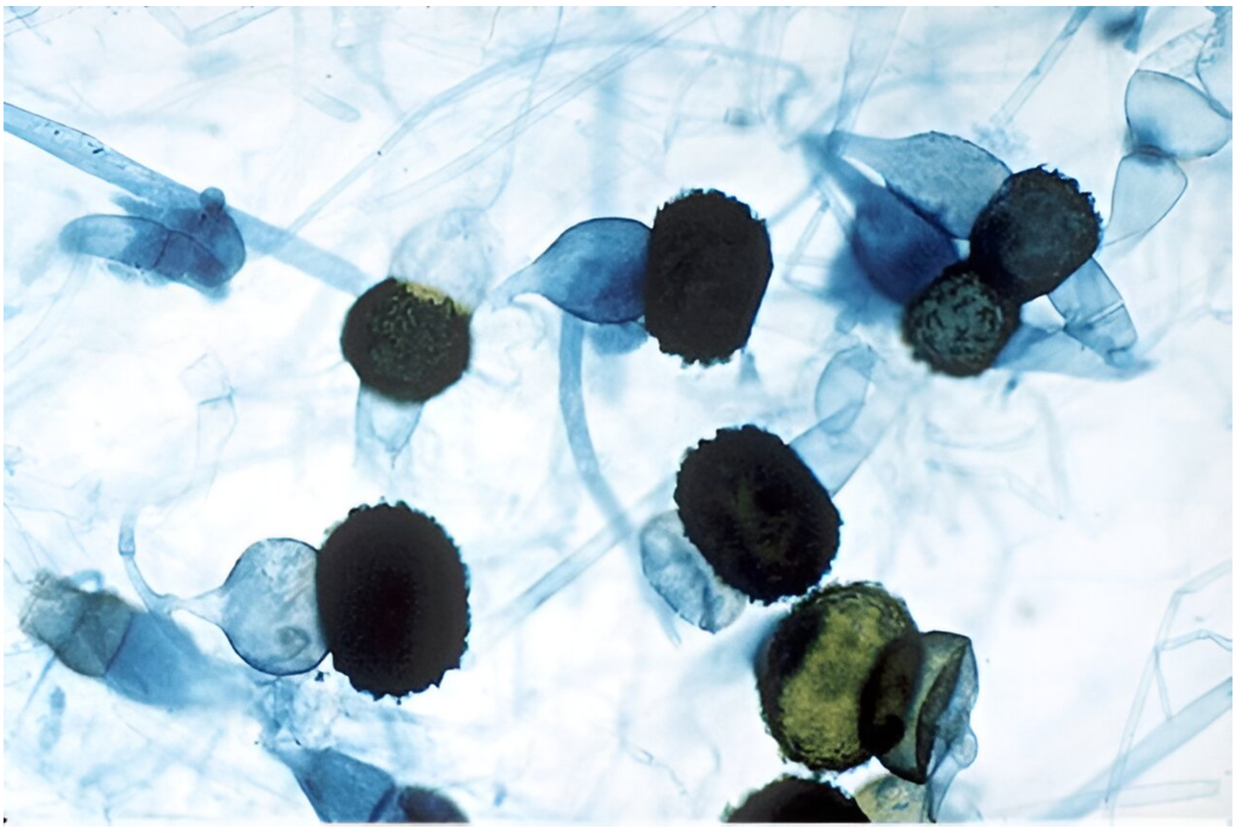
Salt, microbes, acid and heat in food preservation

January 19 2024



Rhizopus spores, from the genus of fungi used in the production of soy ferments. Source: Wikimedia commons

In an era of grocery stores and home refrigerators, it is easy to lose sight of the fact that, for most of history, people have been bound by the seasonality of food. This reality has long presented humanity with a conundrum: how to keep eating after the harvest is over?

In food-insecure regions of the world, the "hunger gap," or period of time between when the previous season's food resources run low and when the next harvest arrives, remains a real and persistent issue. A good harvest—and the ability to make it last as long as possible—has been a song of life and death for humanity for millennia.

Methods of food preservation to address lean seasons throughout history have taken fascinating twists according to region and culture. There are the much beloved stinky cheeses of France, the tart sauerkraut of Germany (which actually originated in China), miso paste in Japan, salted fish in Iceland and the cured meats of multiple cultures stretching into ancient history, to name just a few. Some methods of preservation have sought to minimize microbe involvement by making foods hostile to microbial settlement, while others have embraced microbial life to make many of the specialties we know and love today.

Warding off microbes: curing, drying and canning

It may be no coincidence that some of the key components of flavor are also things that help protect food from microbial misanthropes. Let's look at some time-tested ways to make food hostile to microbes while still keeping it edible to humans.

Salt and sun: curing and drying

Salting fish and meat goes back millennia in human history and is featured in many cultures around the world. Hunting or slaughtering a large animal provides a lot of nutrient-rich meat at once—much more than an average family can consume before it spoils. Before freezers became widespread around the 1940s, humans needed other ways to make the nutrients in meat last, and salt became a viable option.

Salt dehydrates meat and can act as an antiseptic. Large amounts of sodium reduce what is referred to as the 'water activity' of a food, or the amount of free water available for bacteria to use. While not all microbes are killed by high salinity, many potential pathogens die by osmosis as the salt draws all the water out of them. Others simply find it too energetically costly to survive.

The food industry still uses salt for food preservation today, though not in the ways one might think. For example, highly processed foods are notorious for being astronomically high in sodium (more than 70% of the average person's daily intake). This is, in part, so that packaged foods can sit on shelves for years without spoiling.

Salt is not the only way to dehydrate, however. The sun has also come in handy for many a gardener looking to sock away baskets upon baskets of tomatoes, fruit or other produce. Similar to salted foods, foods dehydrated by the sun (or modern dehydrators) lack much of the water that microbes need to survive, and this deters them from setting up shop.

Acid and heat: canning

Once a somewhat forgotten old-timey art (akin to churning butter), home canning is back in full force. While curing is traditionally done for meat and fish, canning shines for preserving fruits and vegetables, which have higher natural water content. The principle of canning has 2 primary elements: heat and acid. The temperature needed to sterilize the food will depend on the acid-content of the food being canned. This is because Clostridium botulinum, a spore-forming bacterium (of botulism notoriety), can persist and thrive when the pH is above 4.6, even after boiling. For this reason, many canned preserves incorporate naturally acidic foods or else supplement with lemon juice or other acids to reduce the pH in the canning environment.

Pressurization is another way to ensure proper temperatures are reached to eliminate spore-forming microbes. C. botulinum spores, the primary concern for canning safety, are very difficult to destroy at normal boiling temperature (212°F). However, by pressurizing the canning environment, temperatures can reach the ~250°F needed to fully eradicate the spores of C. botulinum and other spore-forming microbial contaminants. Low-acid foods must therefore be canned in a pressurized canning system to ensure proper, safe temperatures are reached.

Fermentation

Many people don't need to be encouraged to love some of fermentation's darlings, such as cheese, beer, wine, miso or kombucha. Moreover, as scientists have begun to unravel the mysteries of the gut microbiome, fermented foods have earned their proper reputation as gut health superstars. All the same, many fermented foods have humble beginnings in humanity's quest to keep food around.

Many fermented foods utilize lactic acid bacteria (LAB) to metabolize sugars into lactic acid and carbon dioxide. Similar to the benefits of acid in canning, the lactic acid produced by LAB lowers the pH of the preserved food and helps keep pathogenic microbes at bay. This acidity also gives many fermented foods their characteristic tangy or sour flavor profile. The gas production of lactic acid metabolism can also contribute to the fizzy or bubbly characteristics of beverages like kombucha or beer, or the rising of sourdough bread.

How microbes make fermented foods

Different species of LAB produce unique organic compounds that alter the flavor profile of the food undergoing fermentation. For example, some LAB produce compounds called esters that may give off a fruity flavor. Other LAB may produce compounds like diacetyl, which help lend creamy notes to foods like yogurt and cheese.

Many LAB are familiar friends: Lactobacillus and Bifidobacteria, known to many from conventional probiotics. But the lactic-acid metabolizing category extends to also several other genera like Streptococcus, Leuconostoc, Pediococcus and Enterococcus. Each of these bacterial families produce unique aromatic compounds and vitamins that impact the flavor, texture and nutritional profile of the food in question.

Yogurt, for example, is produced with a relatively brief fermentation of the lactose in milk over the course of 8-12 hours. In that time, Lactobacillus, Streptococcus acidophilus and sometimes Bifidobacteria team up to digest the lactose and produce lactic acid, which denatures and coagulates the proteins in milk to produce a thicker and tangier product.

Cheese, by contrast, is a little more complicated. Just about all cheese starts out looking the same. And yet, over the course of days, weeks and even months, the storage conditions of different cheeses cultivate unique microbial ecosystems that blossom into the distinct and sometimes pungent flavors we recognize. We have hundreds of species of bacteria and fungi to thank for that. In addition to LAB, which digest the lactose and coagulate the dairy proteins into curds over time, other bacteria, yeasts and molds are also used to impart familiar flavors and textures to cheese. For example, Propionibacterium freudenreichii produces gas that creates the characteristic holes of Swiss cheese. The mold Penicillium roqueforti creates the characteristic blue veins that stem through Roquefort and Bleu cheese.

Not all fermented foods primarily feature LAB. Common soy ferments like miso and tempeh rely on fungi for their primary characteristics. Tempeh, for instance, is a lightly fermented soybean cake from Indonesia that is fermented with the help of the fungus from the Rhizopus genus. This genus of organic-matter-digesting fungi is often found on plants when humidity is high enough. In the production of tempeh, Rhizopus oligosporus forms a cohesive network around the soybeans and breaks down proteins to make them more digestible. Similar to LAB, Rhizopus produces gas that aerates the tempeh and produces compounds that suppress pathogen growth.

There are countless other stories behind how we get beer, wine, sourdough, kimchi, sauerkraut and many other fermented foods, and each of them feature unique populations of microbes. LAB are common to many of them, along with fungi, yeasts and molds.

Why preserve food today?

With all of the convenient and time-saving gadgets around, what is the point of fermenting or storing food anymore?

One lasting benefit of food preservation is minimizing waste and keeping food local. While many people no longer have to eat locally with the seasons, choosing to do so can reduce the fossil fuels that would have been used to transport unseasonal produce. This can have a positive impact on the carbon footprint of our diet. Limiting food waste also mitigates the waste of the water and other resources used to grow that food. Not to mention, anyone who has enjoyed a glut of fresh garden tomatoes knows that homegrown food is often more delicious than food that was picked before it was ripe to travel around the world.

Fermented foods in particular are also nature's probiotic. It is no coincidence that many commercial probiotics contain some of the same types of bacteria—Lactobacillus and Bifidobacteria—that contribute to many beloved fermented foods. While it is still an active topic of research and debate, some studies suggest that fermented foods can help provide anti-inflammatory and health-promoting signals to the body, especially when consumed regularly. LAB also produce a host of vitamins and short-chain-fatty-acids that have been shown to benefit human health.

When buying foods that were traditionally fermented, be sure that the food actually does contain an active culture. The advancement of food science has unfortunately made it easy to replicate the familiar flavors of fermented foods (such as pickles) without incorporating the actual microbes that make them so beneficial.

Better yet, try your hand at some of your own fermented masterpieces. Fermenting your own food is straightforward and delicious. Yogurt is an easy place to start, but kombucha, kimchi and sourdough are all popular and delicious ways to dip your feet in.

Provided by American Society for Microbiology

Citation: Salt, microbes, acid and heat in food preservation (2024, January 19) retrieved 27 April 2024 from https://phys.org/news/2024-01-salt-microbes-acid-food.html