Brining Techniques

BRINING FOOD has been used as a cooking technique for hundreds of years. Recently, brining has gained popularity because it preserves, flavors, tenderizes, and adds moisture to many cooked meats. When brine is used with fruits or vegetables, it is commonly called pickling. Brining is chemistry in action.

Objective:

Analyze the chemical process of brining food.

Key Terms:

brine
brining
curing
denatures
diffusion
Kosher salt
membranes
nitrates
osmosis
pH scale
pickling
protein modification
smoked
solutes

The Chemistry of Brining

Brine is a simple and strong salt-water solution used to treat or steep food to preserve its color and to prepare foods for preservation: pickling, keeping, or bottling. Brine for meats is an aromatic (onion, carrot, and celery) liquid into which herbs and salt are added. Brine solutions can be a mixture of salt, saltpeter, sugars (e.g., granulated, brown, molasses, and honey to improve browning), spices, herbs, and water for salting meat to keep and preserve it. Most brined meat is later cooked (e.g., grilled, smoked, baked, or deep-fried). Brining adds flavor and tenderness. In addition, it reduces cooking time.

Brines for pickling vegetables extract natural sugars and moisture to guard against bacterial spoilage. A 10 percent brine solution is the strongest used for food processing. The 10 percent brine solution is made from 1½ cup pickling salt dissolved in 1 gallon of liquid (or 6 tablespoons of salt per quart of liquid). Brines improve the juiciness and moisture content of pork, poultry, and shellfish.

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BRINING

Brining is the process of immersing foods, usually meats, in a solution of liquid, salt, sugar (not always), and desired spices and herbs. Brining liquid that soaks fruits or vegetables is typically called **pickling**. Because cucumbers are so frequently brined, they are known as "pickles," although the pickling process is the same regardless of the type of produce. The brining process is generally used with two food groups: meats and produce.

Meat

Brining adds flavor and moisture to meat. Brined meat (e.g., corned beef and turkey) must be kept at temperatures of 36° to 38°F to prevent food-borne disease. The term "corn" (in corned beef) is from the Anglo-Saxon word for granule or pellet that refers to the salt grains used to make brine.

Produce

Brining or pickling produce adds flavor and preserves the food for an extended shelf life. Typically, produce that has been pickled is kept in sealed jars that have been processed to prevent bacterial growth. As a result, they are stable in long, unrefrigerated storage until opened. Examples are olives, sauerkraut, fruits, cherries, and cucumbers.

Meats for Brining

The brining liquid for meats is heated to dissolve the sugar and salt. The liquid is cooled before adding the meat to prevent excessive bacterial growth. Meat brining is always conducted under refrigeration to prevent bacterial growth by keeping raw meats out of the temperature danger zone. Brine for meats should never be reused due to the level of bacterial contamination from raw meats.

Lean and mild flavor meats, typically those that need to be fully cooked (e.g., not served rare or medium) and can become overcooked and dry, are good choices for brining. Also, some poultry and some seafood are excellent choices for brining. Further, the planned cooking method can make brining less or more attractive as a pre-cooking technique. Cooking methods in which high or prolonged dry heat is used quickly remove moisture from the food. Brining is an

FIGURE 1. Brining meat is simply immersing and soaking in a solution. Chicken is a good meat choice for liquid brining. Most meat and poultry brines add aromatics—carrots, onions, celery—and other spices, herbs, and vegetables to add flavor.

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exceptionally good choice when it is desirable to add moisture and flavor to the meat prior to cooking, resulting in a moister finished product. Pork loin, ham, beef brisket, chicken, and turkey are examples of lean, mild-flavored meats that have great results from brining.

Meats to be **smoked** (a long, slow, drying processes in which meats are exposed to vapor and gases at low temperatures) greatly benefit from brining before the smoking process begins. Smoking adds flavor to meats and has some preservative qualities. Brined meats stay moister and have increased flavors when smoked. Conversely, game birds (e.g., duck and geese), lamb, and prime rib all have high fat content and tend to retain their juices and flavors better during cooking, making them poor choices for brining. No remarkable benefit results from brining these foods.

Vegetables and Fruits

Most vegetables and some fruits are pickled, though it is a far more common choice for vegetables because salt is the predominant flavoring ingredient in the brining solution. The salty flavor is better suited to vegetable flesh than to fruit flesh.

Firm and crunchy vegetables—cucumbers, peppers, olives, cabbage, green tomatoes, onions, beets, carrots, broccoli, and cauliflower—are perfectly suited for brining (or pickling). However, green leafy vegetables are not suitable for brining because of their delicate nature. Also, delicate fruits with high water content (e.g., berries and oranges) are not suited for brining because they fall apart. Yet firm fruits produce excellent results when pickled, especially apples, pears, and cherries.

Pickling is a preservation method. Pickled fruits and vegetables last for months in sealed jars. Pickling has no real time limit because at a certain point food stops absorbing the brine, but pickling does require a minimum of several days.

FIGURE 2. Pickled foods, when properly jarred or canned, last for months and often longer.

Fish and Seafood

Fish with high fat content (e.g., whole salmon rather than steaks or filets) have little need for brining. However, if the whole fish is to be grilled or smoked (taking more cooking time), brining provides excellent results. All lean fish that will be cooked with long or high heat will benefit from brining and its flavoring and moisture retention.

Seafood that is mushy in texture (shrimp) and large cuts of fish that will be cooked for long periods or cooked under high heat (e.g., grilling or broiling) benefit from brining. Aside from adding moisture and flavor, the brine actually firms softer seafood.

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CURING

Curing is a preservation process accomplished by drying, salting, or smoking to draw out water (diffusion) from meat, leaving it less susceptible to bacterial growth. Curing temperatures are 36° to 40°F. Curing may introduce nitrates into food. High-fat foods are cured (e.g., bacon, ham, sausage, and whole salmon). In its truest form, curing literally means to "save" or "preserve." Brining, in its truest form, does not preserve. Its goal is to tenderize and keep meats moist during cooking. Factors that influence curing include:

- Temperature: A higher temperature results in a faster curing process.
- Size: A larger piece of meat takes longer to cure.
- Moisture: More moisture results in a longer curing time.
- Salt concentration: Higher salt concentration results in a shorter curing time. Meat cured only with salt has a better flavor but does develop a dark color that may be objectionable to some consumers.
- Fat: A higher fat content results in a slower curing time.
- pH level: A lower pH results in a faster curing time.

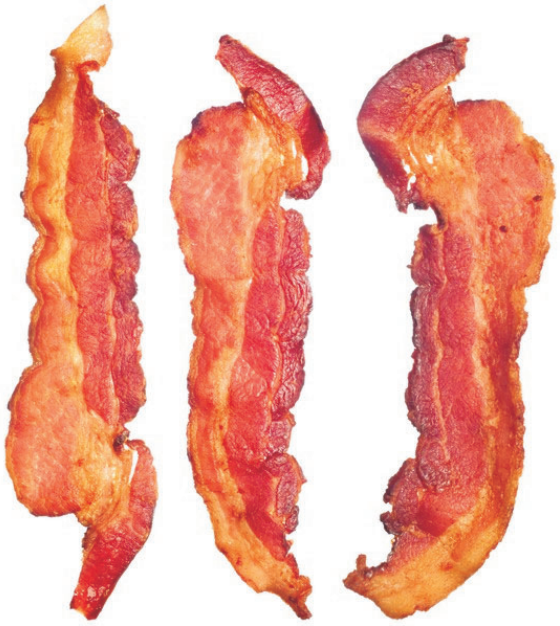

FIGURE 3. Cured meats tend to be high in fat, have salty flavors, and commonly include nitrates. Examples of cured meats are this Serrano ham and the thinly sliced Prosciutto di Parma ham.

Nitrates

Nitrates are a naturally occurring mineral rich in sodium and nitrogen that inhibit bacterial growth and are particularly useful in preserving meats. Nitrates in meats provide a distinctive flavor (a flavor often tempered by subsequent smoking) and tend to alter the color of meat to pinkish or brownish. A common nitrate used to cure meats is sodium nitrate ($NaNO_3$). It does not cure meat directly; at its introduction to meat, not much happens. Eventually, micrococci bacteria in the meat start to react with nitrate and create sodium nitrite ($NaNO_2$) to start the curing process. If too few micrococci bacteria are present, the curing process may be inhibited. However, adding nitrites to meat improves the flavor, prevents food poisoning, tenderizes, and develops the pink color widely known and associated with smoked meats.

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THE CHEMICAL PROCESS OF BRINING

Brining is a simple and fairly quick process, regardless of the meat being used. Though formulas for the solution vary from source to source, the differences are minor. A basic brining solution for meats, poultry, and seafood requires ¾ cup of salt and ⅓ cup of sugar per quart of liquid. These measurements are volume, not weight. This is important because not all salt products are of the same consistency, size, or texture. Brining and pickling alter the following properties of food: water balance, taste and flavor, texture and color, and shelf life.

Osmosis

Osmosis is the movement of a fluid (water) through a semipermeable membrane into a solution of higher solute concentration or a process of absorption. Brining involves salt and osmosis to exchange the fluid in the brine with the water inside the meat. By immersing meats in a liquid with a higher concentration of salt, the liquid is absorbed into the meat. Any flavoring added to the brine is carried into the meat by osmosis with the saltwater mixture. Loading the meat with extra moisture means the brined meat will stay moist longer while it cooks.

Food cells are surrounded and sealed with thin **membranes** (walls). While the membranes hold the cells intact and keep cells separate, liquids can move in and out of membranes. The movement of liquid in and out of cells through membrane walls is the process of osmosis. Typically, differing solute levels between the food and the liquid encourage this water movement through cells. **Solutes** are dissolved salt and/or sugar levels in liquids or moist foods. The liquid tends to move toward solutes until the solute level in the food and liquid reach the same level.

Diffusion

Diffusion is the movement of solutes in and out of cells, while osmosis is the movement of liquid in and out of cells. When salt and sugar are dissolved in liquid and food is placed into that liquid, the solutes are able to pass through the membrane of the food, making it saltier or sweeter. This chemical reaction continues until the food is removed from the brine or the brine solute level is the same as the food. Because salt and sugar attract moisture, their presence in foods tends to increase the food weight because of moisture absorption.

FIGURE 4. Diffusion tends to dry out meats and leave them salty as part of the curing process. These dry salamis are an example of diffusion preservation.

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Protein Modification

Protein modification is a process that changes the chemical structure of meat proteins. Brining modifies the chemical arrangement of proteins by fracturing some of the bonds that give protein its shape. The salt **denatures** (disrupts the normal alpha-helix and beta sheets in a protein and uncoils it into a random shape) the meat proteins, which causes them to uncoil and form a shape that traps water. Protein bonds are very responsive to changes in temperature, acidity, and salinity, causing the proteins to decompose slightly in brines. As a result, the salt, sugar, and other flavoring agents infuse the flesh of the foods.

As proteins cook, they coagulate or solidify. The more they "tighten," the more moisture is lost, leaving the meat dry and tough. Typically, protein in meat coagulates tightly at about 160°F. Brined meat's "tight" coagulation occurs at about 180°F. (This is best exemplified in the way salt melts ice by raising the freezing temperature of water by 20 degrees.)

Brined meats are more tender and are moister than meats cooked by dry heat methods because more liquid is absorbed during brining, so the constriction of meat proteins is delayed by about 20 degrees.

Salt

Salt dissolves protein in muscle, which causes the protein to change and trap more moisture. A combination of protein modification and salt results in reduced moisture loss during smoking.

Kosher salt is a large-grained, flakey salt made without the iodine and anti-caking additives in table salt. While table salt dissolves easily and runs off meat, the larger Kosher salt crystals disperse more evenly and cling to meat. The weight of one cup of Kosher salt is less than the weight of one cup of table salt. Chemically, Kosher salt works like any other salt. However, the lack of iodine and anti-caking chemicals in Kosher salt make it the preferred salt choice for brine preparation.

FIGURE 5. Notice how large these Kosher salt crystals are compared to table salt. Kosher salt is the preferred salt choice to make brine.

The ratio of brine to meat is generally one quart of brine per pound of meat. The salt-to-sugar ratio to liquid is variable for brines. However, one way to test that the brine contains a minimum salt to sugar ratio solution is that a raw shell egg floats in the brine. If the egg does not float, the ratio is insufficient. Heavily salted water is denser than unsalted water. Therefore, solid foods will float in heavily salted water.

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BROADENING AWARENESS...

AMAZING ASPECTS: Salting and Nitrate History

Salting (and smoking) of meat is an ancient practice used for preservation. It is believed that primitive tribes used smoking as a preservation method but with inadequate results; the meat still rotted. American Indians had better luck hanging meat to dry in teepees and exposing it to campfire smoke. Throughout history, fish and meat have been heavily salted and dried as a preservation method, requiring the soaking of the food in water to rehydrate it and remove the excess salt before cooking.

What these ancient people did not know (circa 850 B.C.) is that nitrates were a naturally occurring impurity in salt. Romans were the first to notice the "reddening" effect of salting meats: a sure sign that nitrates are present. The true role, affects, and manipulation of nitrates in food was not fully understood and used until the 20th century. Regardless, salts and nitrates were used in food and allowed for the availability of nourishment to mankind for many centuries before scientific knowledge caught up.

Four Variables in Brine Composition

Liquid, pH levels, time, and immersion are four variables in brine composition.

Liquid

The brine liquid is typically water, or at least part water, and may include flavorful aromatic vegetables and liquids (e.g., juices, beers, or vinegars). Naturally, flavorful liquids impart their own flavor to the brine. Care is taken not to over-flavor meats. Acidic liquids also affect the proteins in meat by making the meat more tender.

pH Levels

All liquids fall on the pH scale. The **pH** (potential of Hydrogen) **scale** is a figure representing the acidity or alkalinity of a solution ranging from 0 to 14 on a logarithmic scale. It is important to remember that 7 is neutral (pure water is 7 on the pH scale), less than 7 is more acidic, and more than 7 is more basic.

In brining, acids break down muscle tissue (meat), tenderize it, and may add a tangy flavor. Only mildly acidic liquids (4.5 to 6 on the pH scale), such as juices and vinegars, are used in brining (if used at all). Acid in brines causes tissue (meat) to break down, resulting in the ability of meat to hold more liquid, even though diffusion tends to draw liquid out of the cells. Meat brined in acid solutions tends to weigh a bit more due to absorption of liquid.

Time

The length of time meat is left in brine varies based on size and how much added flavor is desired. Brining is conducted for a minimum of 30 minutes and up to 30 hours. A basic rule is one hour per pound in the solution. However, this could be higher for large turkeys or other large cuts of meat. If the meat is to be grilled for long periods of time, the sugar level in the

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brine should be reduced to prevent burning or excessive browning. Over-brining will result in excessively salty food. Herbs and spices (e.g., dill, bay leaf, pepper, chili peppers, and basil) may or may not be included in the brine. It is a matter of taste.

Immersion

Meat must stay fully immersed in the brine (no part above the liquid line). Often the meat is weighted to keep it from floating in the brine mixture.

Summary:

Brining is an old technique to preserve food still used today for meat, fish, seafood, and produce. Brining tenderizes and keeps meat moist while adding flavor by soaking it in a solution of liquid, salt, sugar, and flavorings. When vegetables are brined, it is typically called "pickling."

Curing is a preservation process accomplished by drying, salting, or smoking—a process that draws water out of meat, leaving it less susceptible to bacterial growth. Curing temperatures are 36° to 40°F. Curing may introduce nitrates into food. High-fat foods often are cured (e.g., bacon, ham, sausage, and whole salmon).

Osmosis is the movement of a fluid (water) through a semipermeable membrane into a solution of higher solute concentration; it is a process of absorption. Diffusion is the movement of solutes in and out of cells, while osmosis is the movement of liquid in and out of cells.

Checking Your Knowledge:

1. What is the difference between brining and curing?
2. What type of salt is the preferred choice for brining, and why?
3. What is osmosis? How does osmosis aid brining?
4. What is diffusion? How does diffusion aid food preservation?
5. Which foods are best suited for pickling? Which foods are best suited for brining? Explain.

Expanding Your Knowledge:

Ham and corned beef are different meats but both are brined or cured. They are also both pinkish in color. Why? Ham is commonly smoked, but corned beef is not. While Kosher salt is the preferred salt for brining, it is not the typical choice for either of these meats. What is? Is there a connection between the "mystery" salt and the color of the meat? What else might change the color of the meat to pinkish?

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Conduct some research to find the answers to these questions. Create a PowerPoint presentation for your class based on your findings.

Web Links:

Brining

http://www.cookingforengineers.com/article/70/Brining

Brine a Turkey

http://www.youtube.com/watch?v=moDuqN2lNtc

Meat Curing

http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2055/ANSI-3994web.pdf

Brine Pickles

http://www.perfectpickler.com/what-are-brine-pickles/

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