



## Smoking Your Catch: Do it Safely!

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### **Tasty, but it can be lethal!**

After a successful fishing trip, you may want to smoke your catch and enjoy it later. Smoked fish is is delicious, but if you don't prepare it correctly, it can also be lethal. Several types of food poisoning bacteria can survive, or even grow, on smoked fish that is incorrectly prepared or stored.

#### ***Clostridium botulinum***

The most dangerous of these bacteria is *Clostridium botulinum*, which causes the potentially lethal illness called botulism. This bacterium produces heat-resistant endospores that can survive the smoking process, so it is essential that the composition of the smoked fish and its storage temperature prevent endospore germination and subsequent growth of cells.

#### ***Listeria monocytogenes***

The bacterium *Listeria monocytogenes*, recently linked to processed meats and dairy products, can contaminate finished smoked fish if proper sanitary practices are not followed. This bacterium can cause serious illness in pregnant women, immunocompromised persons, and young children. *Listeria monocytogenes* will not survive smoking. But, if it contaminates fish that has already been smoked, *Listeria monocytogenes* can grow - even if the smoked fish is properly refrigerated.

#### **Keys to safe smoked fish**

To keep your smoked fish safe from these food poisoning bacteria, you must:

- Make sure that there is enough salt absorbed by the fish flesh before smoking. This hinders the germination of *Clostridium botulinum* endospores.
- Make sure that the internal temperature of the fish during smoking gets hot enough to kill bacteria, like *Listeria monocytogenes*, that do not form heat-resistant endospores.
- Handle the finished smoked fish in a sanitary manner so that food poisoning bacteria, such as *Listeria monocytogenes*, do not contaminate it.
- Store the smoked fish at a cold enough temperature to prevent germination and growth by *Clostridium botulinum*.

We'll discuss each of these points in more detail, but first let's talk about deciding which fish to smoke.

#### **Selection of Fish for Smoking**

Fish that are relatively rich in oil are best for smoking because the oil absorbs the smoky flavor well and prevents undesirably dry texture. In the Great Lakes region, species such as trout, chubs, whitefish, and salmon are excellent choices for smoking. Small fish can be gutted and smoked; larger fish can be smoked as whole gutted fish, fillets, or chunks. No matter what type or form of fish you wish to smoke, follow the basic steps shown here.

#### **Fish Preparation**

Smoking will not improve the quality of poorly handled fish. The most important steps in proper fish handling are to quickly bleed, clean, and cool the fish.

The sooner you bleed the fish, the less blood remains- meaning better appearance and keeping quality. Promptly removing the gills, intestinal tract, and kidney will also dramatically improve keeping quality. The gills contain large numbers of spoilage bacteria and should be removed first. Given enough time, enzymes in the intestine can degrade the wall of the belly cavity, allowing huge numbers of bacteria to invade the flesh, so remove the intestinal tract next. The kidney contains enzymes that can produce off-flavors, so remove it, too. Rinse all fish surfaces with cold running water to remove blood, slime, and foreign material.

Once the fish is bled and cleaned, cool it as rapidly as possible. Ice is a much better coolant than water. In fact 2 pounds of melting ice has the same cooling power as 7 pounds of water at 32°F! To get the most out of melting ice, it must directly touch the fish. If air is between the fish and the ice, cooling power is much slower. Insulating air pockets can exist between large pieces of ice and fish, so use crushed or flake ice if it is available. When icing your catch, make sure the ice completely surrounds the fish, including inside the belly cavity. If you decide to freeze the fish, wrap it in a moisture vapor-resistant covering to prevent freezer burn. If properly wrapped and stored at 0°F or colder, fish can be stored frozen for 6 – 9 months without appreciable loss of quality. Frozen fish should always be thawed in the refrigerator or under cool running water.

### **Salting**

Proper salting is a key step for the flavor and safety of smoked fish. Before salting, you may want to subdivide your cleaned and cooled fish. Whether you will be smoking whole fish, fillets, or steaks, make sure that their size is as uniform as possible. This ensures that the same amount of salt is absorbed during salting and that all of the pieces receive the required amount of heat without overcooking. Without doing a chemical analysis, it's hard to be certain that fish has absorbed enough salt. This is why proper hot smoking and subsequent refrigerated storage are also necessary to ensure a safe product.

Salting is most effectively done using brine. To make brine, mix 1 part salt with 7 parts of water (for example, 1 cup of salt plus 7 cups of water). If you have purchased a salimeter to measure the salt content of the brine, this ratio of salt and water will read approximately 60° on the salimeter scale. The length of time to keep the fish in the brine varies depending on the size, species, and form of fish used; the relative proportion of fish and brine, how long the fish has been chilled, and whether it has been frozen. In general, larger or oilier fish will require a longer salting time, and smaller fish or fish that have been refrigerated a long time or frozen will require less time.

For every 2 –3 pounds of fish, use 1 cup of salt + 7 cups of water. Some starting points for determining salting time would be 30 minutes for small gutted fish, and 2 hours for larger fish or chunks from large fish. You may wish to use a considerably longer salting time and a less concentrated brine; if you plan on salting for more than 4 hours, be sure the brine is refrigerated at 38°F or colder. Dry salting will also work, but it is easier to attain uniform salting with brine. It may take several batches to perfect your salting technique. The final smoked fish should taste salty, but not unpleasantly so.

When the salting is done, rinse and air-dry all fish before smoking. Rinsing will remove salt-tolerant bacteria that may cause spoilage and drying will help smoke deposit evenly on the fish surface during smoking. Smoke does not deposit well on a wet surface. If you do not have suitable conditions for drying, you can place the salted fish in the smokehouse with low heat (80-

90°F), no smoke (if using wood, use a low, clean flame), and doors open. If the fish are placed on a screen for drying, be sure to turn them occasionally so they will dry evenly and not stick to the screen during smoking. The time required for drying will vary. On a low humidity day, drying should take 1 – 2 hours.

### Smoking and Cooking

In terms of safety, the most important part of this step is to ensure that the thickest part (the “cold point”) of the largest fish is heated to at least 160°F for at least 30 minutes. This heating, along with proper refrigeration of the finished product, is essential to prevent botulism! A typical fish-smoking process should bring the cold point temperature to over 160°F in 6 – 8 hours.

Remember, the critical temperature is the fish cold point temperature, not the oven temperature! To achieve this fish cold point temperature, your smokehouse oven temperature must reach 200 – 225°F. If your smokehouse cannot reach this temperature range in 8 hours, you’ll have to perform the final cooking in your kitchen oven. If it takes longer than 8 hours for the fish internal temperature to reach 160°F, spoilage may result from bacterial growth when the fish is at ideal growth temperatures (90-120°F).

To check the fish cold point temperature, use a standard meat thermometer. Remember that the cold point is the coldest part of the largest fish. An additional factor to consider is that many smokehouses do not heat evenly. If you can determine the area of the smokehouse that is slowest to heat up, the largest fish should be placed in this area during smoking. Doing this means that all of the other fish/pieces are smaller and in warmer areas of the smokehouse. Thus, if the cold point in the largest fish reaches 160°F in the coldest area of the smokehouse, all of the other fish/pieces will be sufficiently cooked, too. To monitor the oven temperature, insert a long-stemmed dial thermometer (capable of indicating from room temperature to 250°F) through a hole in the smokehouse wall.

Although reaching the 160°F fish cold point temperature is critical for safety, you do not want the fish to reach this temperature too quickly. A period of 3 – 5 hours should elapse before increasing the oven temperature to raise the fish cold point temperature to 160°F. Heating the fish too quickly will result in a baked flavor and an undesirable “curd” formation caused by water boiling out of the fish. A typical fish cold point temperature profile during smoking is shown in Figure 1. Note that the fish cold point temperature always “lags” below the oven temperature. Once the fish cold point temperature has been at least 160°F for at least 30 minutes, you can do further smoking and drying. But, make sure that the fish cold point temperature remains above 150°F until cooling is started.

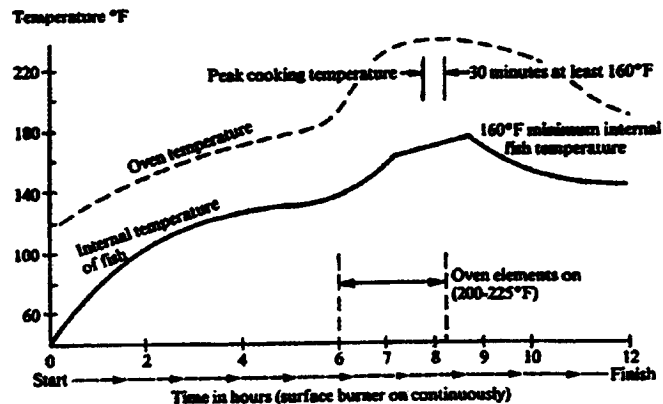
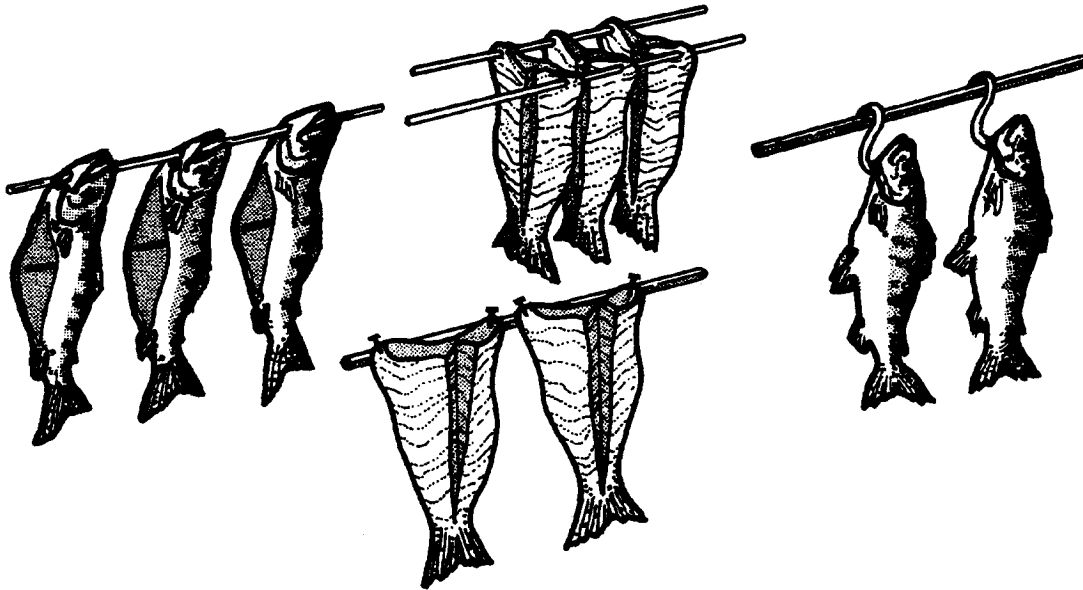


Figure 1.—Typical internal fish temperature during smoking cycle.

Many small smokehouses rely on the natural movement of smoke from the bottom of the smokehouse to the top. For these smokehouses, the most even heating results when the fish or pieces hang vertically. To hang the fish you can use metal rods, wooden dowels, S-shaped hooks made from 8 – or 10-gauge steel wire, or hooks made from clothes hangers (Figure 2). If your smokehouse has forced smoke movement (a fan or blow dryer may be adapted for this purpose), you may be able to get even heating with the fish placed horizontally on racks made from hardware cloth or screening. When hanging whole gutted fish or placing them on horizontal racks, be sure to use a piece of dowel or screen to hold open the belly cavity (Figure 2). Otherwise, the air in the belly cavity will act as an insulator and slow the heating of the fish flesh.



In smoking fish, always remember that heat is critical for safety. The smoke alone is not an effective preservative under most smokehouse conditions. Smoke is important for flavor, though. Smoke made from hardwoods such as maple, oak, alder, hickory, birch, and fruit woods are regarded as good fish-smoking woods. Softwoods such as pine, spruce, and fir are not recommended. Wood can be chipped or cut into pieces about 8 inches long and 1 inch in diameter. If you use sawdust, be sure that it comes from one of the recommended woods. Don't use sawdust from fiberboard or plywood – it may contain adhesives that are toxic or cause off-flavors.

A common question is whether the small metal smokehouses available in hardware or sporting goods store are safe for smoking fish. These smokehouses will result in good smoked fish flavor, but may not be capable of producing a fish cold point temperature of 160°F or hotter. If this is the case, you may need to use your kitchen oven to achieve the fish cold point temperature/time combination.

#### **The fish are smoked... Now what?**

The smoked fish you have produced still has the potential to be unsafe. Because you do not know the salt concentration in the finished product, you must assume that *Clostridium botulinum* endospores survived smoking and could germinate and grow. To prevent germination and growth, smoked fish must be refrigerated at 38°F or colder, or be frozen. A recommended time limit for refrigerating smoked fish is 14 days.

You must also take steps to ensure that you do not contaminate the finished smoked fish with dangerous bacteria such as *Listeria monocytogenes*. Before bringing the smoked fish out of the smokehouse, be sure that all surfaces that might contact the fish have been thoroughly cleaned and then sanitized with a sodium hypochlorite (bleach) solution. To make the bleach solution, add ½ ounce of ordinary (unscented) household bleach to one gallon of water. After sanitizing surfaces, let them air dry. Wash your hands thoroughly before handling the smoked fish. You may want to wear latex or vinyl gloves, also. Just remember that gloves can become contaminated just like hands, so they should be periodically washed and sanitized, or discarded.

Let the smoked fish air-cool before packaging it. Otherwise, condensation will form on the packaging and encourage mold growth. Also, the fish flesh will be soft and difficult to handle when it is first removed from the smokehouse. Wrapping the smoked fish in a porous material such as paper towel will also inhibit mold growth by preventing migration of moisture from the fish to the packaging. If you do not think that you will eat the smoked fish within 14 days, tightly wrap the smoked fish in a moisture vapor-resistant covering and freeze it. Because the smoked fish has relatively low moisture content, little quality will be lost during frozen storage of up to four months.

#### **A word about liquid smoke and sodium nitrite cures**

Some recipes for smoked fish call for the use of liquid smoke. Liquid smoke will have an impact on flavor, but it does not significantly improve the safety of the product. You must still follow the salting, fish cold point temperature, and cold storage guidelines we've discussed. Many cure mixes are available for adding to the fish during brining or dry salting. If the cure mix contains sodium nitrite, it may reduce or eliminate the chances of *Clostridium botulinum* growth. However, you have no way of knowing whether the necessary sodium nitrite concentration has been achieved throughout the fish, so you should still follow the guidelines in this fact sheet.

#### **For more information...**

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