**Training Supplement: Understanding the potential hazards associated with preserving fish by smoking**

Smoked fish has been implicated in *Clostridium botulinum* outbreaks since the 1960s. As a result, several states including New York, Michigan, Wisconsin, Alaska, Minnesota and North Carolina have established more rigorous standards for the safe processing of smoked fish. The types of *Clostridium botulinum* associated with the marine environment are *Clostridium botulinum* Type E and non-proteolytica strains of Type B and type F, which have been associated with botulism outbreaks with smoked fish. These marine strains of *Clostridium* are “non-proteolytic” organisms, which do not break down proteins and form gas and “off” odors as the “proteolytic” forms do. The off odors usually cause consumers to reject the product and not consume it. Since non-proteolytic organisms do not cause off odors, they make smoked fish exceptionally risky.

Smoked fish is a product that may be produced at retail. The 2022 FDA Food Code prohibits fish from being reduced oxygen packaged at retail unless the product is frozen before, during, and after packaging. In addition, smoked fish cannot be produced at a retail store without a variance and a HACCP plan.

The type of fish chosen for smoking is important. Fish from the scombroid species have been implicated in scombroid poisoning. The most common types of scombroid fish are tuna, bluefish, mahi-mahi and mackerel. These fish can produce elevated levels of histamine if temperature abused during harvesting, handling, processing or storage. Histamines are not destroyed by freezing, cooking, smoking, curing or canning. Persons who are sensitive to histamines may experience severe allergic reactions and anaphylaxis as a result of exposure.

Parasites are a concern with certain species of fish. They can be destroyed by heat during hot smoking. Cold smoking, on the other hand, does not have a heating step. Therefore, parasites must be controlled by freezing the fish. The Food Code provides guidance for parasite destruction in Section 3-402.11 and 3-402.12.

A retail establishment may receive fish for smoking that are either eviscerated or uneviscerated. Evisceration is cutting down the belly of a fish and removing the internal organs. Fish should be carefully eviscerated and the visceral cavity thoroughly rinsed to eliminate *Clostridium botulinum* spores that are commonly present in the digestive tract. Evisceration should be performed with minimal disturbance of the intestinal tract contents.

[Listeria monocytogenes](https://www.fda.gov/food/foodborne-pathogens/listeria-listeriosis) is another concern when handling fish. The best way to control for [Listeria monocytogenes](https://www.fda.gov/food/foodborne-pathogens/listeria-listeriosis) is to use proper sanitation and prevent cross contamination of raw products. This organism is a huge concern with cold smoked fish as there is no known control measure to eliminate L. monocytogenes on cold smoked product, unless it is cooked prior to eating, by the consumer.

Nitrites can only be used for salmon, shad, sable fish and chubs in accordance with FDA regulations (21 CFR 172.175 & 21 CFR 172.177). Without the presence of added nitrite, water phase salt content greater than 2.5% is recommended along with drying to prevent growth and toxin formation by *Clostridium botulinum*. *Listeria monocytogenes* can also multiply in the ROP environment. To control these two significant potential hazards, refrigeration below 38oF and date marking are critical to controlling these hazards. The use of nitrite also poses potential risks, if used in excess of FDA-specified concentration limits in the finished product. Use of too little nitrite is also potentially risky in that this may allow growth and toxin formation by *Clostridium botulinum*.

Human pathogens, such as *E. coli* O157:H7, other pathogenic *E. coli* strains and *Salmonella,* *Shigella*, *Staphylococcus aureus*, Norovirus and Hepatitis A virus can be transmitted by human carriers to food through improper hygienic practices and failure to follow the employee health policy. FDA has identified worker hygienic practices as a major risk factor at retail, which creates risk of infecting customers who consume those foods. Toxins from toxin-forming bacteria such as *Clostridium botulinum* and *Staphylococcus aureus* cannot be destroyed by normal cooking. Hepatitis A virus cannot be destroyed by cooking at temperatures lower than 190oF. Proper handwashing, glove use and other procedures for handling of ready-to-eat foods, good employee hygienic practices, and carefully following the Employee Health Policy are essential to preventing contamination of food and protecting the health of consumers.

Preserving safe food by curing and smoking relies on proper use of the above controls, as well as other essential practices such as effective sanitation, good employee hygienic practices and health, and date marking products for shelf life. These additional procedures become even more important in preventing cross-contamination when the finished product is considered ready-to-eat.

**Definitions of HACCP Terms:**

***Corrective action*:** one or more actions to be taken when monitoring at a CCP demonstrates failure to meet a critical limit. Corrective actions should address the actual *cause* of the observed problem. Example: If an oven fails to reach the set temperature, corrective action *may* be to repair or replace the oven.

***Critical Control Point (CCP)*:** A process step at which control must be applied, to prevent or eliminate a hazard, or to reduce it to an acceptable level.

***Critical Limit (CL)*:** The maximum or minimum allowed value for a control measure, separating acceptability from unacceptability. For example, cooking instructions: “Cook to at least 165oF for 15 seconds at the thickest part of the thickest piece of chicken in the coolest part of the oven.” At retail level, most CLs are defined by regulations (example: SC Regulation 61-25). Critical Limits established in the HACCP Plan must be no less strict than current regulatory standards.

***Flow diagram*:** A visual illustration of the sequence of steps in a food preparation process, from receiving of raw materials to the finished product as it is presented to the customer.

***HACCP Plan*:** a written document based on international standards for HACCP, defining the formal procedures to be followed to assure control of identified food safety hazards in a specific process.

***Hazard*:** A biological, chemical, or physical contaminant that has the potential to cause injury, illness, or death. Salmonella, cleaning chemicals, and bone fragments are examples of the three types of hazards.

***Hazard analysis*:** The process of collecting and evaluating information on potential hazards and the conditions leading to their presence, to identify significant hazards that must be addressed in the HACCP Plan.

***Monitoring*:** Conducting ongoing, planned routine observations or measurements of control parameters to determine whether a CCP is under control. Recording measurements of batch temperatures, cooking times, and verifying presence of batch date marks are examples of monitoring.

***Prerequisite Programs (PRPs)*:** Programs, policies and procedures that are separate from the HACCP Plan, but which are essential to the effectiveness of the HACCP Plan. PRPs are a critical part of any food production operation. Examples of PRPs include sanitation procedures (SSOPs), pest control, supplier approval and purchasing specifications, employee hygiene policy, hand-washing requirements, no bare-hands contact with ready-to-eat foods policy, employee training procedures, and good retail practices.

***Preventive (control) measure*:** an action or activity in a food preparation process that is used to prevent or eliminate a food safety hazard, or to reduce that hazard to an acceptable level. Examples: approved supplier; freezing fish for parasite destruction.

***Validation*:** Obtaining technical evidence that the elements of the HACCP Plan for your process are capable of achieving their intended purpose. May include such materials as scientific literature, regulatory references, a Product Assessment, or testing data from your own process monitoring.

***Verification*:** The use of observations, procedures, tests, auditing, or other means, *other than routine monitoring activities*, to assess compliance with the HACCP Plan. Examples include managerial review of temperature charts, batch pH records, thermometer calibration records, and planned observation of employee hand-washing procedures.