

Chapter 2: Battered Fish and Fishery Products

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Potential Food Safety Hazard

Staphylococcus aureus toxin formation in hydrated batter mixes can cause consumer illness. This toxin in particular is a concern because the toxin cannot be destroyed by heating steps that may be performed by the processor or the consumer. Pathogens other than *S. aureus* are, in many cases, less likely to grow in hydrated batter mixes, and are likely to be killed by the heating steps that follow (FDA, 2011).

Control Measures

S. aureus can enter the process on raw materials. It can also be introduced into foods during processing from unclean hands and insanitary utensils and equipment.

The hazard develops when a batter mix is exposed to temperatures favorable for *S. aureus* growth for sufficient time to permit toxin development. *S. aureus* toxin does not normally reach levels that will cause food poisoning until the numbers of the pathogen reach 500,000 to 1,000,000/gram. *S. aureus* will grow at temperatures as low as 44.6°F (7°C) and at a water activity as low as 0.83 (additional information on conditions favorable to *S. aureus* growth are provided in [Table A-1](#)). However, toxin formation is not likely at temperatures lower than 50°F (10°C) or at water activity below 0.85. For this reason, toxin formation can be controlled by minimizing exposure of hydrated batter mixes to temperatures above 50°F (10°C). Exposure times greater than 12 hours for temperatures between 50°F (10°C) and 70°F (21.1°C) could result in toxin formation. Exposure times greater than 3 hours for temperatures above 70°F (21.1°C) could also result in toxin formation (FDA, 2011)

FDA Guidelines

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- Hydrated batter mix temperatures should not exceed 10°C (50°F) for more than 12 h, cumulatively; and

- Hydrated batter mix temperatures should not exceed 21.1°C (70°F) for more than 3 h, cumulatively (FDA, 2011).

Critical Aspects of Processes

Critical aspects of battered fish and fishery product processes may include:

- Temperature of the hydrated batter;
- Length of time the hydrated batter has been held at temperatures above 10°C (50°F);
- Accuracy of thermometers, recorder thermometer charts, high temperature alarms, maximum indicating thermometers, and/or digital data loggers;
- Accuracy of other monitoring and timing instruments (FDA, 1998).

Analytical Procedures

Thermometer calibration

All thermometers should be calibrated daily to be certain the correct temperatures are being measured. An inaccurate thermometer reading is as flawed as using improper procedures while taking temperatures--because either way the wrong information is being recorded. To calibrate a thermometer only takes a few minutes and is essential for good business practices.

Calibration with ice

The temperature of a freshwater ice-water slurry is 0°C (32°F), the freezing/melting temperature of freshwater. Fill a plastic or metal container (a large Styrofoam cup, for example) with chipped or crushed ice; then add clean freshwater to a depth of at least 10 cm (4 inches). Stir the ice and water for a minimum of 2 minutes to be certain the water is completely cooled and good mixing has occurred. Always make certain there is plenty of ice in the mixture, and be sure to use freshwater, not seawater.

Dial thermometers

Immerse the stem of the dial thermometer in the ice-water slurry for a minimum of 2 minutes. After 2 minutes, read the temperature on the thermometer(s) without removing it (them) from the ice/water slurry. Adjust the thermometer to 0°C (32°F), if necessary, by gripping the hex nut under the dial with a wrench or pliers and turning the dial face until the pointer reads the temperature correctly. To check several thermometers for accuracy at the same time, punch holes in a plastic lid and insert the thermometers through the holes and into the ice-water slurry. Paper clips may be formed to hold the thermometers in place. The thermometers should not touch the sides or the bottom of the container nor should they touch each other. The case around the dial thermometer generally has a metal hoop on the pocket clip that can be used to hold the thermometer in an ice-water slurry.

Electronic thermometers

Immerse the probe of the electronic thermometer in the ice/water slurry for a minimum of 2 minutes. After 2 minutes, read the temperatures without removing the probe from the ice/water slurry. Adjust the thermometer to 0°C (32°F), if necessary, by following the manufacturer's directions. These thermometers are generally adjusted with a zeroing screw.

Calibration with boiling water - at sea-level and standard atmospheric pressures

This is much more dangerous than calibrating with ice so be extra careful. You must first calculate the boiling point of freshwater for your working altitude. See the section on physical constants for the factors to use to calculate the adjusted boiling point.

Due to the complexity involved in calibrating a thermometer in boiling water, this method should only be used to confirm that a thermometer calibration at 0°C (32°F) is measuring accurately at higher temperatures.

Heat the fresh water until a rolling boil is achieved. Immerse the stem of the dial thermometer or the probe of the electronic thermometer in the boiling water for a minimum of 1 minute. After at least a minute, read the temperatures on the thermometer without removing it from the boiling water. Adjust the thermometer as necessary to the calculated boiling point for the altitude and atmospheric pressure.

Physical constants

The formulas for converting between Fahrenheit and Celsius temperature scales are:

$$^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{F} = 32 + ^{\circ}\text{C} \times 9/5$$

The normal human body temperature is 37°C (98.6°F). Freshwater boils at 100°C (212°F) at sea level at a standard atmospheric pressure (760 mm Hg), and freezes at 0°C (32°F). The freezing point of water does not change with normal variations of atmospheric pressure.

The boiling point of water varies with changes in atmospheric pressure; at higher altitudes the boiling point of water is lowered depending on the altitude. If you are using the boiling point of water to calibrate a thermometer, you must estimate the boiling point is based on your altitude. In general, for each 293 meter (960-foot) increase in altitude the boiling point changes by 1°C (1.8°F), however, it is the change in atmospheric pressure that causes the change in the boiling point. Please refer to a handbook of chemistry and physics for the exact boiling point of water at different atmospheric (vapor) pressures. To properly determine the atmospheric pressure you will also need a barometer (De Beer, 1998).

References

De Beer, J. 1998. "Accurately measuring seafood temperatures."
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