Paralytic Shellfish Toxins in Butter Clam Tissues

Sea Grant Alaska

Background

Butter clams, *Saxidomus giganteus*

Paralytic Shellfish Poisoning (PSP) is a persistent problem that affects Alaska subsistence and recreational shellfish harvesting. PSP is caused by consumption of shellfish that have accumulated saxitoxins (STXs), potent neurotoxins produced by the marine dinoflagellate *Alexandrium*. STXs disrupt normal nerve function and can result in respiratory paralysis. The collective term STXs refers to over 20 chemical variants, each with a specific name and level of toxicity. Bivalve shellfish species differ in how they process the STXs, and STXs can concentrate in different shellfish tissues. This knowledge has led to numerous inquiries by shellfish harvesters regarding how shellfish cleaning methods might affect the amount of STXs consumed. Accordingly, this document focuses on one of the most commonly sought-after subsistence bivalves, butter clams.

Kodiak shellfish are known to have very high levels of PSP toxins that have caused severe illness and deaths. The regulatory limit for safe shellfish consumption is 80 micrograms of toxin per 100 grams of shellfish tissue **(80 µg STX / 100 g shellfish tissue)**. In the Kodiak region, toxin levels have measured as high as 8,532 µg STX / 100 g in butter clams, and 20,606 µg STX / 100 g in blue mussels. Efforts are ongoing to address the problem through research, monitoring and education. Toxin monitoring in butter clams has been conducted in the Kodiak region since 2013. During this time, butter clam toxicity was consistently too high for safe harvesting (Figure 1).

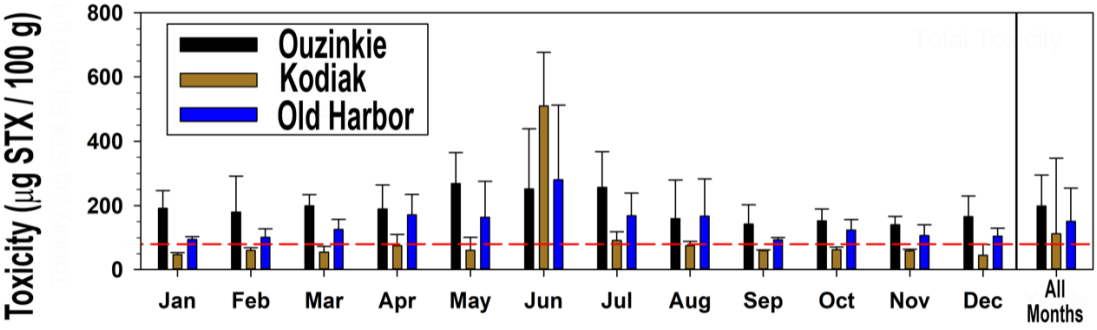
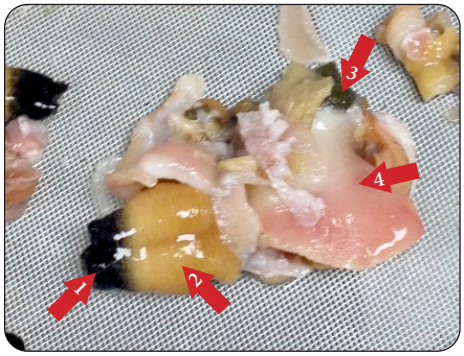


Figure 1. Average monthly butter clam toxicity (µg STX / 100 g) ± standard deviation in butter clams collected in 2013–2019 from Sourdough Flats, Ouzinkie; Near Island, Kodiak; and Shipwreck Beach, Old Harbor. The red dashed line is the FDA regulatory limit.

Toxins in butter clam tissues

In response to harvester-specific questions, **this study addressed the difference in toxicity between whole and cleaned butter clams.** We looked at the distribution of STXs in butter clam tissues on a seasonal basis and evaluated cleaning methods used by harvesters.

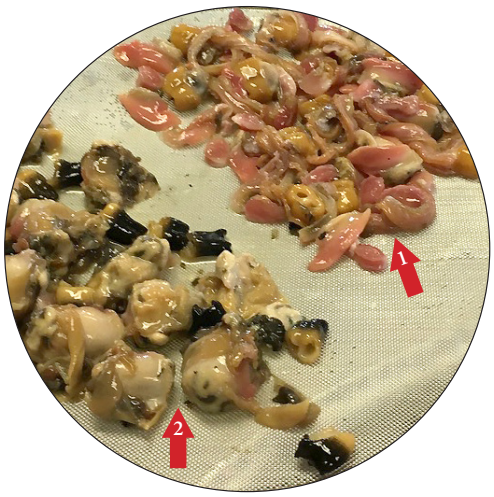
Butter clams are known to accumulate high levels of toxins and retain them for long periods. Previous research has shown that butter clams store large amounts of toxins in the siphon. Our data agreed with these results, and further showed toxin levels to be present in different tissues seasonally. In the summer, STXs are first observed to increase in the gut when *Alexandrium* cells are present in high numbers. The prevalent forms of toxin found in the gut are gonyautoxins (GTXs), which are quickly distributed throughout other parts of the clam. Over time, butter clams chemically modify the GTXs in their tissues to produce saxitoxin (STX) and neosaxitoxin (neoSTX), which are more toxic variants. During the winter, the STX and neoSTX continue to concentrate in the black siphon tip and the siphon neck.



Butter clam tissue preparation. (1) black siphon tip, (2) siphon neck, (3) gut content, (4) body meat.

Effect of cleaning butter clams

In an attempt to reduce PSP risk, some harvesters "clean" butter clams by removing tissues with known or suspected toxins. We examined three different cleaning methods used by Kodiak harvesters. Tissues were segregated into edible and discarded tissues according to judgment by the harvester. Toxin concentrations were measured in each fraction and the percent toxicity by weight was calculated to compare the contribution of each tissue type to the overall toxicity of the clam. Method 1 included minimal processing with the black siphon tip removed. Method 2 involved moderate processing with removal of the black siphon tip, brown tissues and gills; the gut content was gently squeezed out. Method 3 was maximum processing with the black siphon tip and brown tissues removed, and the gut fully cut away.



Harvester cleaning Method 3, separation of (1) edible and (2) discarded tissue.

The study showed a reduction of butter clam toxin levels of 7–18% using cleaning Method 1, reduction of 12–76% with Method 2, and 9–89% reduction using Method 3. The wide ranges in toxicity reduction reflect changes in the seasonal distribution of STXs in the butter clam tissues and the variability in toxin concentrations among individual butter clams. Because the distribution and abundance of toxic *Alexandrium* cells is patchy, and varies seasonally, it is very difficult to predict when or where particular shellfish will be toxic.

Even with maximum processing, where about 50% of the clam tissue was discarded, **there was not a 100% removal of toxins. And in many samples the remaining edible tissues still contained toxin levels unsafe for consumption.** While toxicity exposure can be reduced by removal of certain tissues, particularly the black siphon tip and the gut, **the effectiveness of the cleaning strategies to remove toxins varies greatly and is not predictable.** The toxicity of the "cleaned" meat is dependent on the time of harvest, location of harvest and variation in the toxicity of individual clams.

Summary

- PSP toxins increase dramatically during the summer months due to the seasonal increase of the toxic *Alexandrium* cells. In Kodiak, toxins begin to increase in April and can remain elevated through September.
- Risk of PSP exists year-round because toxins can be retained in some bivalve shellfish.
- Butter clams can accumulate very high levels of toxins and retain toxins for long periods.
- PSP toxin distribution in butter clam tissues changes seasonally, as do the forms of toxins (STX, neoSTX, GTXs).
- Removing the black siphon tip, at least half of the siphon neck and the gut content in butter clams is recommended if harvesters choose to eat untested clams; a percentage of toxin is reduced. However, the effectiveness of the toxin removal varies and is not predictable.
- **Removal of these tissues does not guarantee processed butter clams will be toxin-free. Toxin levels can remain above recommended limits in the "cleaned" meat.**
- Where extreme toxin concentrations are common, such as Kodiak, it can be assumed that the STXs will be present in all edible tissues.
- **The practice of harvest and hold is recommended.** Harvest the clams, sacrifice some of the clams for testing, and wait for test results before consuming. Only testing ensures safe consumption.

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Full project results can be found at North Pacific Research Board, http://projects.nprb.org; search project #1616.

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