A preliminary investigation of smooth dogfish (*Mustelus canis*) at-sea processing techniques

Abstract: *Smooth dogfish (Mustelus canis) are a commercially landed shark species on the east coast of the United States. A preliminary investigation was undertaken to determine the extent to which smooth dogfish meat turns green and spoils as a result of various processing and storage methods available to commercial fishermen. Smooth dogfish can be effectively processed while maintaining all fins naturally attached. Observations of the meat over 4 hours after processing reveals that meat can be stored without turning green if kept on ice or in an iced brine solution.*

Figure 1. Smooth dogfish processed at-sea with varying preservation and processing methods.
Left: Freshly processed smooth dogfish with head and guts removed, blood line cleaned, and pectoral fins attached.
Right: 4 treatment sharks with varying post-processing times (from bottom to top): Treatment #1 (4 ½ hrs), Treatment #2 (4 *1/3* hrs), and 2 Treatment #3 sharks (4 hrs) (3 ½ hrs), respectively. The Treatment #1 shark shows signs of drying from exposure to air and heat and the lack of refrigeration, but no green coloration was observed, while other treatments remained fresh looking over 4 hours post-processing.

Figure 2. Smooth dogfish are commonly processed at-sea, removing pectoral and other fins and the belly flap, sometimes hours after the fish died.
Left: Treatment #1 shark processed as commercial fishermen often do, with the body (left), belly flap (bottom right), and 2 pectoral fins (top right). Fishermen may also cut other fins to minimize further processing at the dock.
Right: Treatment #4 shark processed 2 hours after death with the flesh remaining white, with an opaque white body cavity lining. No foul smell was detected from the meat and no green coloration was observed.

Introduction:

Smooth dogfish (*Mustelus canis*) are a commercially landed shark species on the east coast of the United States. Smooth dogfish are most commonly caught using gillnets, with the fishery occurring primarily off of North Carolina from March through June. In 2008, the North Carolina gillnet fishery landed 826,028 pounds of smooth dogfish with an estimated value of $265,402 (NCDMF 2010). Delaware, New Jersey, New York, and Rhode Island also commercially landed smooth dogfish in 2008 (NMFS 2010). Overall, the smooth dogfish fishery has annual directed landings, containing minimal bycatch, with sharks landed for both their meat and fins (NMFS 2010b).

It is commonly stated that in order to maintain the quality of shark meat, sharks must be bled and iced down as soon as possible after being landed. The kidney in sharks produces non-protein nitrogenous compounds that are present in the muscles and blood. Once dead, these compounds are converted into ammonia and trimethylamine oxide (TMAO) by bacterial enzymatic action (Otwell *et al*. 1985). Though all shark fisheries share this problem, smooth dogfish meat has been known to spoil faster than most shark species (ASMFC 2009). Smooth dogfish are landed in a high volume gillnet fishery, wherein dogfish are hand-picked from nets while one person processes the catch at-sea. After the head is removed and the body is eviscerated, dogfish are either stored in ice or in an iced brine solution. Marketable smooth dogfish must be properly gutted and bled, with meat characterized by a bright white coloration, opaque white membrane inside the body cavity, and tenderness to the touch.

Though not well documented, it has been stated that time is a significant limiting factor in the smooth dogfish fishery, with dogfish needing to be cleaned within 15 to 20 minutes after being landed to avoid spoilage (Marcagger 2009 YouTube video and Otwell *et al*. 1985). The Atlantic States Marine Fisheries Commission (ASMFC), the management authority of the smooth dogfish fishery, had received comments from fishermen stating that it is necessary to remove the fins from smooth dogfish to maintain the quality of the meat. The fishermen also stated that a prohibition on finning would hinder their ability to properly bleed the shark and prolong the time before meat can be refrigerated, resulting in a poor quality product. Overall, it has been stated that "requiring the fins to remain attached is simply incompatible with the nature of the commercial smooth dogfish fishery" (ASMFC 2009), and ASMFC representatives have stated that this requirement would put a number of fishermen out of business (O'Shea 2009, unpublished). Ultimately, the prohibition on finning has been viewed as "unnecessary and overly burdensome" (ASMFC News Release 2009). The purpose of this study was to test the null hypothesis that the quality of smooth dogfish meat is not impacted by requiring fins to be naturally attached through offloading, as gauged by the presence of green coloration and smell of the meat. Further, we tested whether smooth dogfish can be processed at-sea with all fins left naturally attached and the effort required to do so as compared to current processing methods.

Methods:

Five smooth dogfish were landed using hook-and-line gear near Atlantic Beach, North Carolina on Wednesday, May 21, 2010. It was a warm spring day, during the peak season for smooth dogfish in North Carolina, with air temperatures ranging from 56 to 65 degrees Fahrenheit and water temperatures near 65 degrees Fahrenheit.

The inshore waters near Shackleford Banks and Beaufort Inlet were fished, where the highest abundances of dogfish were observed.

Research was conducted using a time-elapsed experiment, in which smooth dogfish were landed and processed at-sea using varying processing and storage methods, with all guts and blood lines removed from the dorsal surface of the body cavity. Treatment #1 processed smooth dogfish as commercial fishermen commonly do, with a single cut to remove the head and guts and subsequent cuts to remove the belly flap and pectoral fins. The body and belly flap were then laid out on the deck to determine how long it would take for meat to spoil in the absence of refrigeration. Treatment #2 processed dogfish at-sea with all fins remaining naturally attached. To accomplish this, the head was first removed, then the belly flap was cut on each side and subsequently cut off, while leaving all fins naturally attached. To remove the belly flap while maintaining pectoral fins' attachment to the body required additional cuts; first slightly splitting the belly flap before making two diagonal cuts from the slit to just posterior to each pectoral fin. The dogfish was then gutted and the body and belly flap were stored on ice. Treatment #3 was processed in the same manner as Treatment #2, but with dogfish stored in an iced brine solution using sea water. Finally, Treatment #4 did not process the dogfish, instead leaving the body exposed to the environment without refrigeration for 2 hours before processing. All smooth dogfish were observed at 30 minute intervals to note the color and quality of the meat and the temperature of each treatment was measured using a mercury thermometer. Photos were taken to record the condition of all treatments.

Results:

Over the course of observations on May 21, no evidence of green dogfish meat was observed. Treatment #1 resulted in a decrease in meat quality as compared to refrigerated treatments, with meat no longer marketable when left out for nearly two hours after it was processed. Treatment #2 and #3 both resulted in marketable quality meat after over 4 hours post-processing (Figure 1). In general, the iced brine solution was most effective at maintaining the freshest quality meat as compared to plain ice or no refrigeration. Treatment #4 showed no signs of green coloration and did not smell foul; however the shark processed was a very small female, with a proportionally smaller liver and kidney than the other sharks processed that day or commercially. The meat was still white with the white membrane inside the body cavity opaque white (Figure 2). Processing with fins attached in Treatments 2, 3 and 4 showed no observable negative effect on the quality of the meat (Figure 1). However, the process required to leave pectoral fins attached to the body required several extra cuts, beyond the current practice used by commercial fishermen to minimize processing time. The time required to process dogfish with all fins naturally attached decreased with increased experience.

Conclusion:

Though requiring increased handling and processing time, claims that requiring fins to be left naturally attached negatively impacted the quality of the meat was not found in this investigation. Further, no evidence of green colored meat was observed, even in the Treatment #4 shark which was not processed for over 2 hours after

death. Treatment #2 and #3 meat remained of high quality in refrigeration, with no visible green coloration present when all fins remained naturally attached.

As a preliminary investigation, without the direct participation of affected commercial fishermen, it is difficult to estimate the true time investment necessary when requiring all fins to be left naturally attached. This investigation shows, however, that this type of processing can be done with minimal effects to the quality of the meat, with no green coloration observed. In general, the time required to process sharks while maintaining all fins attached decreased with experience, but still took additional time compared to current processing techniques. The method used in this investigation can be effectively performed by commercial fishermen to remove the head and eviscerate smooth dogfish while maintaining all fins naturally attached and the integrity of the meat when properly stored, but may require additional processing time and effort.

Shark meat quality is significantly affected by the precision of cleaning undertaken. Regardless of the preservation method used, meat without sufficient cleaning will result in spoilage. It is important to remove the guts and blood line (kidney) from the roof of the body cavity to maintain high quality shark products. Though ice and refrigeration can slow enzymatic action, spoilage is inevitable in sharks where urea or TMAO remain. Salt brine helps extract nitrogenous compounds; however, precaution must be taken to optimize salt concentrations to prevent toughening of the meat. Finally, though some fishermen sever the caudal vein to bleed larger sharks, dogfish can be bled by cutting the branchial region through the gills (Otwell *et al*. 1985), enabling all fins to remain naturally attached.

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