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Detection and Quantification of Lead and Copper in Firearm Harvested Ground Venison Intended for Human Consumption

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http://upload.wikimedia.org/wikipedia/commons/b/b7/White-tailed_deer.jpg

Introduction

Humans have extirpated a majority of the predators responsible for the population regulation of the White-tailed Deer (*Odocoileus virginianus*) in Illinois. The Illinois Department of Natural Resources (IDNR) has established a statewide deer hunting season in order to help manage the deer population. Approximately 180,000 deer are harvested each year during firearm and bow-hunting seasons combined (IDNR 2013). Firearm hunters predominantly use lead or copper ammunition in shotguns, muzzleloader rifles and centerfire pistols to hunt deer.

Lead ammunition often fragments upon impact with game animals, and lead fragments may be ingested by humans and by scavenging animals that feed on unrecovered deer carcasses and offal piles (Bedrosian et al., 2009). Food pantries in North Dakota have been advised by the North Dakota Health Department to not accept ground venison meat donations because of concerns about lead contamination (Cornatzer et al., 2009). Even at low levels, lead is a neurotoxin that can cause nerve damage, hearing and vision problems, compromised reproductive health and improper development in children (National Institute of Health, 2013). Copper, which is less likely to fragment than lead and is less toxic to humans and scavengers, is an alternative to lead ammunition.

The purpose of this study is to determine the presence and concentration of lead and copper fragments in firearm harvested ground venison meant for human consumption. Ground venison samples have been x-rayed, and we are developing protocols to use Anodic Stripping Voltammetry (ASV) and Atomic Absorption Spectroscopy (AA) to verify if these metals are present, and if so, to determine their levels. Although voltammetric studies have previously been used to identify metal contamination in water, this method is novel to lead analysis in game meat.

Methods

- A total of 45 packets of firearm harvested ground venison from the 2013-14 and 2014-15 deer hunting seasons were collected from local hunters.
- The deer were processed at meat plants in central Illinois and custom processed by an individual. 15 bow killed venison packets served as our control
- Venison packets were x-rayed by Dr. Matt Fraker at the Prairie Oak Veterinary Clinic in Bloomington.
- X-ray images were visually inspected to determine the presence of potential fragments. Only potential fragments that had color characteristics similar to reference steel BB's were included in the analysis (Figure 2).
- A series of solutions and test parameters were analyzed using Anodic Stripping Voltammetry (ASV) with a CH Instruments Electrochemical Potentiostat for accuracy in identifying known concentrations of dissolved lead and copper.
- Anodic Stripping Voltammetry analyzes the current produced by a redox reaction as a function of the voltage applied to an electrode in the test solution. The magnitude of this current, and the ionization potential at which it peaks, are specific to certain metals and can be used to calculate concentration within a solution.
- Once a set of test parameters was developed, we made serial dilutions of a solution containing a dissolved lead pellet in an effort to determine the potentiostat's lower detection limit.

Results and Discussion

- There was a significantly greater proportion of firearm killed venison packets that contained fragments (25/30; 83.3%) compared to bow killed venison packets (4/15; 26.7%, $\chi^2_1 = 14.01$, $p < 0.001$; Figures 1 and 2).
- The mean number of fragments per firearm killed packet was 2.1 $\pm$ 1.78 ($\bar{x} \pm$ SD).
- Using the standard addition method for ASV, our optimized parameters yielded significant peaks for lead detection down to 33µg/L (Figure 3).

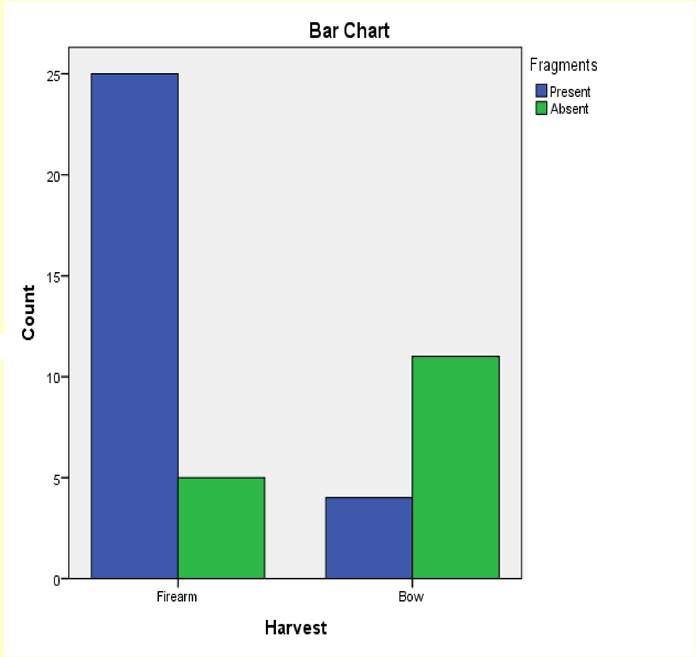

FIGURE 1. The frequency of potential metal fragments in firearm and bow killed ground venison packets.

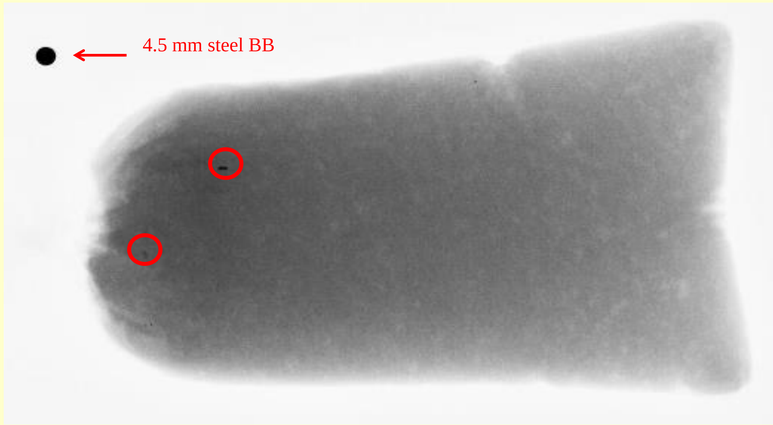

FIGURE 2. Ground venison packet from a deer killed with a lead slug. Circles show potential fragments.

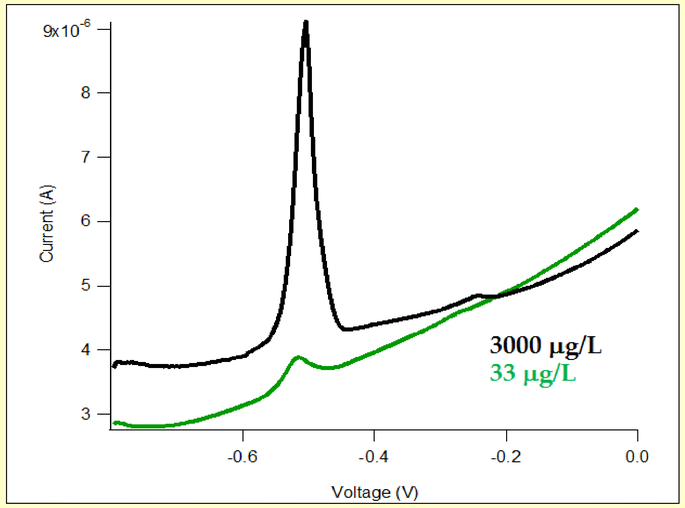

FIGURE 3. Sample peaks obtained for ASV tests: 3000 µg/L and 33 µg/L. This method has proven to be sensitive enough to detect potential metal fragments in future studies

Future Research

- In 2015-2016, we will use ASV and Atomic Absorption Spectroscopy to document and quantify levels of lead and copper in all venison packets.
- It is possible that fragments in bow killed venison packets are bone.

Literature Cited

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