Thallium (Tl) Detection in Beef Prompts Environmental Investigation

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Human and Animal Food

Abstract

In September of 2021, a random sample of beef from a Utah slaughter facility, collected by a Utah Department of Agriculture and Food (UDAF) meat inspector and tested by US Department of Agriculture (USDA) Eastern Lab, was found to contain levels of thallium considered to be unsafe by USDA guidelines. Follow-up testing of various tissue samples from six other carcasses showed elevated levels of thallium.

Further testing revealed that two additional processed beef carcasses from an earlier harvest date were also contaminated. Testing of hair follicles and urine from live animals on the farm also showed detectable levels of thallium. However, no significant amount of thallium was detected in blood samples. Environmental sampling, both on-site and off-site, are ongoing with the intent of locating the possible site and timing of the contamination and exposure source of thallium.

Partners collaborating on the response include the USDA Food Safety and Inspection Service, UDAF, the Utah Department of Health (UDOH), the Utah Department of Environmental Quality, the Bear River Health Department (BRHD) Food and Drug Administration (FDA).

Introduction

Thallium is a naturally occurring element found in trace amounts in the earth's crust. Thallium poisoning is one of the most complex and serious toxicities known to man. In studies of thallium poisonings, people who have ingested large amounts have reported vomiting, diarrhea, alopecia, and effects on the nervous system, lungs, heart, liver, and kidneys.

Tissue samples from a custom slaughter facility collected on September 14, 2021, were found to contain elevated levels of thallium (196 ppb). A UDAF inspector gathered the samples as a part of a routine monitoring program carried out under the guidance of the USDA. The samples were received for testing by the USDA Easter Lab on September 15, 2021.

Six additional animals were butchered at the same time as the original sampled carcass. Further sampling concluded high levels of thallium in all seven carcasses.

Two animals from the same property had been harvested approximately two weeks earlier. The meat from these two animals had been packaged and returned to the owner. Some of the meat was delivered to family members out of state. Ground beef samples were gathered from those animals as well, which also had elevated levels of thallium.

UDAF personnel conducted an environmental assessment of the farm where the animals had been reared. Animal movement, feed, access to water, and other environmental factors were assessed. They collected feed, water, soil, vegetation, battery debris, and chicken egg samples from the farm and the surrounding area. They also collected blood, urine, and hair samples from live cattle. The samples were analyzed for arsenic, cadmium, lead, mercury, and thallium content by the UDAF Lab.

Materials and Methods

UDAF collected muscle (intact cuts of beef or ground beef), liver, and kidney samples from slaughtered cattle. Soil, vegetation, and water samples were collected on-site in clean sampling containers. All samples were prepared for analysis by microwave digestion in acid solution. The prepared samples were analyzed using a Agilent 7800 inductively coupled plasma mass spectrometry (ICP-MS).

UDAF, UDOH, BRHD, and the Eastern Idaho Public Health District (EIPHD) interviewed people potentially affected by this incident regarding beef consumption and potential thallium sources. BRHD and EIPHD collected human urine samples; The Chemical Threats Laboratory at the Utah Public Health Lab analyzed these samples.

Figure 1. Livestock pasturing area.

Results and Discussion

On-farm investigation - Dr Dean Taylor, UDAF State Veterinarian and the Utah Rapid Response Team met with the owner at his farming location on 10/7/2021.

Whole corn feed from a single source had been delivered to the farm in a large tote. A call was made to the corn supplier, and rodent control methods were discussed. There was no evidence found to suspect that poison from rodent bait mixed with the corn. However, some rodent bait was used on the premises. A sample of the corn was gathered and sent to the UDAF Lab. Results indicated no evidence of high levels of thallium content in the feed.

The primary water source for the animals is a river running through the pasture. A water sample was taken from a location where the animals congregate to drink. A water sample was also taken from a new run-off drain which was recently installed to drain water from a new housing sub-division. A sediment sludge sample was taken at the exit point of the drain at the convergence to the river.

Figure 2. Soil sampling on the farm.

Other environmental concerns – The landowner has been on the property for about 4 years. During that time, he noticed areas where the prior owner buried automotive parts and possibly fluids. He had also had issues with a strong gas smell emanating from a sump pump located on the property.

Lab results from tissue sampling indicate the mean concentrations of thallium were highest in the kidney (3,690 ppb), followed by hair follicles (1,974 ppb), liver (491 ppb) and meat (163 ppb) (Table 1). Thallium was also detected in urine, but at lower levels, and was not detected in the blood. These results are consistent with what has been observed in animal and human studies in the literature. Slight differences in thallium concentrations were observed for the three different shaft lengths of the hair follicles with the highest levels in the middle segment of the hair.

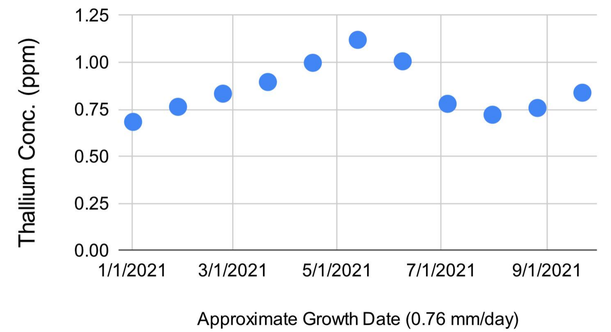
Table 1. Summary results for thallium levels (ppb) in beef tissue samples.

Tissue	N[a]	Mean	Range
Meat [b]	7	224	114–286
Hair follicle (0-8 cm)	3	1,384	752–2,035
Hair follicle (8-16 cm)	3	1,974	960–3,153
Hair follicle (16-24 cm)	3	1,167	635–1,217
Blood	5	—	ND[c]
Urine	5	—	4[d] <LOQ[e]–135
Liver	1	—	491
Kidney	3	3,690	3,502–4,061

[a]N = sample size [b]Includes ground beef and steak [c]ND = non detect
[d]Number of samples <LOQ [e]LOQ = limit of quantification

Hair from one of the animals was selected for further hair segment analysis with a segment length of 2 cm. The data from the analysis was used with an approximate hair growth rate for cows, 0.76 mm/day, to create Table 2. These initial results seem to indicate that the thallium is persistent in the environment of the cows. However, the change in concentration over time may help to identify the source of the thallium with further investigation.

Table 2. Thallium Concentration vs. Growth Date



Conclusion

Thallium contamination is very rare in food. Prior to this incident, FSIS has never detected thallium (above its limit of detection of 50 ppb) in the >7,000 samples of FSIS-regulated products collected and analyzed during 2013–2021 as part of routine surveillance. The thallium contamination in this situation would likely not have been detected without routine beef sampling, demonstrating the public health value of this surveillance sampling program. It is possible that concerning levels of thallium might be present undetected on other farms. Public health officials should continue to consider the possible food safety risks and sources of thallium and other contaminants.

Thallium's high potential of toxicity in both humans and animals, along with its long-term effects, is concerning. Fortunately, consumption of affected beef in this situation was minimal and thallium exposure does not appear to have caused adverse health effects in people or animals. Future testing of the live animals from the farm will help guide appropriate timing of slaughter for safe beef consumption.

The collaborative relationships already established by partners positioned the URRT to respond to this situation rapidly. The investigation to determine the source and timing of contamination that led to cattle exposure is ongoing. If thallium is found in other places beyond the boundaries of the single farm, a larger investigation will be needed to determine the impact to a larger geographic area and other exposure concerns.