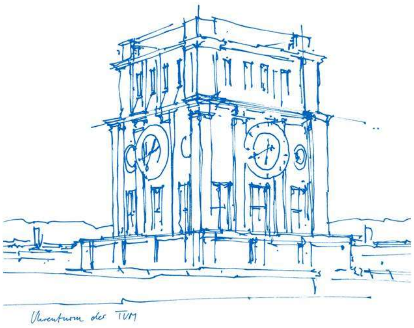
4th Joint Symposium on Nanotechnology

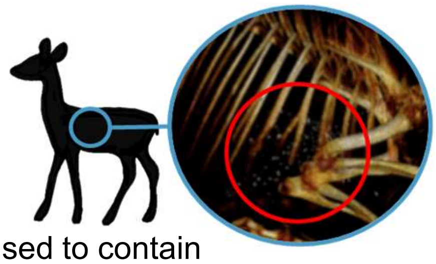
Detection of particulate bullet residues in wild game and cultivated plants

Prof. Dr. Julia Steinhoff-Wagner
Technical University of Munich
TUM School of Life Sciences
Animal Nutrition and Metabolism

Annina Haase & Anne-Christine Krüger
German Federal Institute for Risk Assessment
Department Safety in the Food Chain
BfR-Center for Land Use Related Evaluation Methods, One Health Approaches



Background - detection of bullet residues in food and feed



- Lead intake is toxic to humans and should be avoided
- Game-killing ammunition used to contain mostly lead, but risks for consumers of todays alternative materials such as copper, zinc, bismuth and tungsten are also rarely described
- Relatively frequent cases of increased lead content in game products

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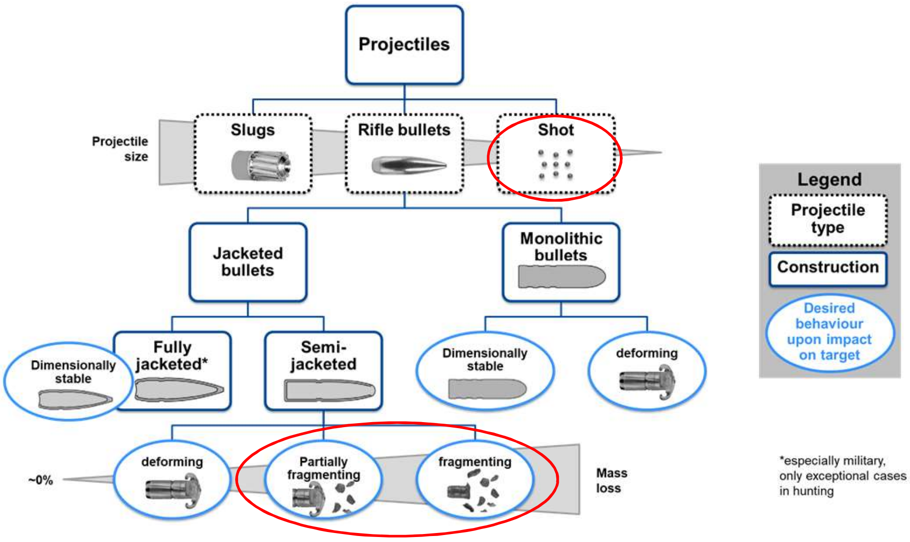
Overview of projectile types for hunting



Haase et al., 2021

Ammunition fragments in game meat

Fragment sizes **Fragment numbers**

nanometers millions

micrometers hundreds

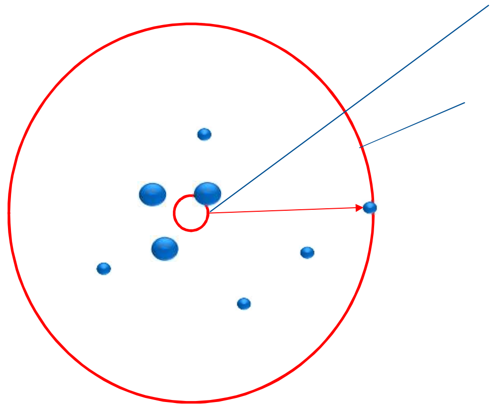
millimeters few

> 40 nm
Singe-Particle Inductively coupled plasma mass spectrometry (sp-ICP-MS)
Kollander et al. 2017

< 1 cm
X-Ray

Haase et al., 2021

Ammunition fragments in game meat



Wound channel determined by bullet flight path

Maximum distance of detected fragments
→ Important for giving practical recommendations to cut out tissue around wound channel for food safety reasons

Challenge:
The smaller the fragments, the longer the distance to the wound channel

up to 15 cm (*Hunt et al. 2006*),
22 cm (*Trinogga et al. 2008*),
45 cm (*Hunt et al. 2009, Grund et al. 2010*)

current recommendation for cutting out tissue

Haase et al., 2021

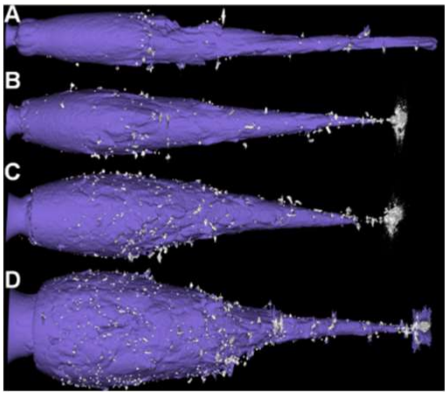
Example of a Pb monitoring result in game meat

Parameter	Result	Unit	Note
Lead (Pb)	54 9.4 3.0 3.8 14 1.6	mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg	The lead values measured scatter very widely, the sample is likely to be very inhomogeneous with regard to this parameter. It is therefore not possible to form an average value from the analysis values, which is why they are listed individually.
Cadmium (Cd)	> LOD	mg/kg	
Mercury (Hg)	0.005 ± 0.001	mg/kg	

RASFF, 2021

Development of methods for preventive risk assessment

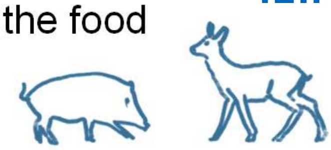
CT representation of the fragmentation plume of a leaded bullet in balistic soap with increasing impact energy (A-D)



Gremse et al., 2014

Tests of projectiles firing at ballistic soap and gelatin → Spatial description of the fragments' position → Resolving of the simulant medium and analytics → …. → Appearence and distribution of nanoparticles

Possible pathways of lead into the food chain via hunting/ shooting



- Rifle bullets → Fragments can be found in the tissue
- Rifle bullets → Missing or shot through as well as the cut of tissue ended up in the environment
- Lead shot → Scatters and only partially gets into the animal/ meat
- Scatters and only partially gets into the animal/ meat → Accumulation of lead compounds in soil and plants
- Get into feed
- Uptake by animals
- Uptake by humans
- Distribution of lead compounds in the environment

Original text excerpt from the ECHA lead restriction report

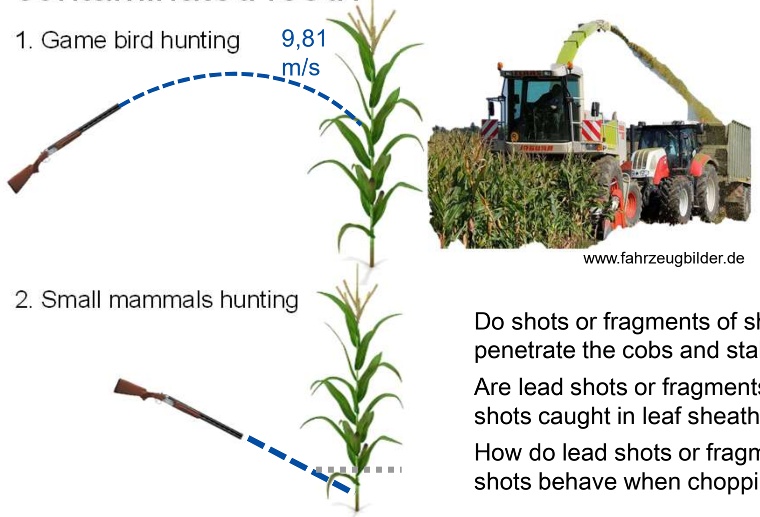
"The **greater toxicological hazard from lead poisoning due to ammunition residue would be from feeding and ingestion of contaminated feed such as corn stock**. Lead shot from rough shooting or organised shooting events can become lodged in broad-leafed vegetation subsequently harvested and processed for silage. The lead shot embedded in feed such as maize can then bypass the rumen reticulum directly to the acidic parts of the gastrointestinal tract. Additionally, the acid conditions produced during the fermentation process of the vegetation provides suitable conditions for the production of lead salts which are more readily absorbed by the ruminant."

ECHA, 2021

Individual cases of lead contamination via animal feed through shotgun ammunition

Feed	Species	Sample/ product of animal origin	Reference
Corn silage (>649 mg/kg, lead shot)	Dairy cows with symptoms of poisoning	Milk (0.06-0.5 mg/L)	*Bischoff et al., 2014*
Grass silage/ Hay	Oxen (dissection after death)	Blood (2.3 mg/L), Kidney (13 mg/kg)	*Rice et al., 1987*
Grass (0.33 mg/kg KG)	Sheep	Liver (0.3 mg/kg)	*Johnsen und Aaneby, 2019*

Which hunting scenarios may lead to contaminated feed?

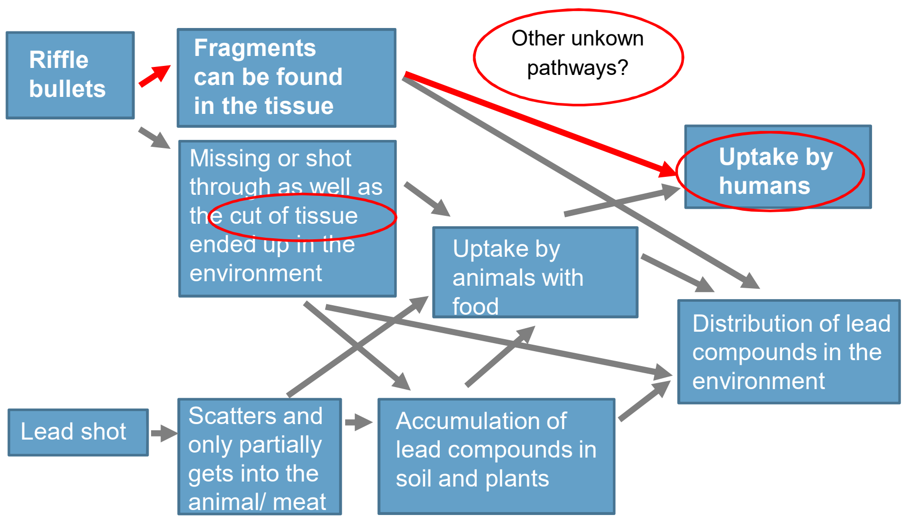


Do shots or fragments of shots penetrate the cobs and stalks?

Are lead shots or fragments of shots caught in leaf sheaths?

How do lead shots or fragments of shots behave when chopping?

Summary and further research questions



Thank you for your attention!

Prof. Dr. Julia Steinhoff-Wagner

mail: jsw@tum.de

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Annina Haase

Anne-Christine Krüger

German Federal Institute for Risk Assessment

Department Safety in the Food Chain

BfR-Center for Land Use Related Evaluation

Methods, One Health Approaches

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