

Bioavailability of lead - influence of kitchen preparation

Food safety of game meat obtained from hunting

14.03.2024, Berlin

Dr. Kirsten Schulz

Unit Feed and Feed Additives

Department Safety in the Food Chain

Project title

Determination of the influence of cooking preparations of game meat on the bioavailability of residues of lead-containing bullets in animal experiments using pigs as a model animal



Universität
Rostock



Traditio et Innovatio

Bayerisches Landesamt für
Gesundheit und Lebensmittelsicherheit



Structure

1. Background information/Conception
2. Trial realization
 - 2.1 Preparation of game meat
 - 2.2 Kitchen preparation
 - 2.3 Feeding trial with pigs
3. Results
4. Conclusion



Background information/Conception

- ammunition-derived lead contributes significantly to lead exposure of people who frequently consume game meat as particle residues are at least partially bioavailable^{1,2,3}
- storage of carcass/kitchen preparation/cooking with acidic components causes chemical reactions and dissolution of lead ammunition fragments^{4,5}
- no health-based guideline value/no safe intake level for lead (ALARA-Prinzip)

¹ Green & Pain (2019) ² Haldimann et al., 2002 ³ Hunt et al., 2009 ⁴ Kollander et al., 2017 ⁵ Mateo et al., 2011

Working hypothesis

- lead-containing fragments remain in edible tissues if lead ammunition is used for hunting
- marinating game meat increases the bioavailability of ammunition lead fragments
- evidence is provided by lead concentration in blood

Trial realization

Preparation of game meat

- September 2013 – February 2014 (Stand hunting and driven hunts)
- leaded ammunition: partial jacket round-head bullet from RWS (caliber 7x64) or Geco partial jacket bullet (caliber 8x57 IS, 30-06 or .308)



Bereitstellung	
Eckdaten zur Proben- und Laufkarte	
Jagdrevier / Jagdgebiet: ...	
Jagdtag: ...	
Jagdrevier / Jagdgebiet: ...	
Gewicht des Schießfadens: ...	
Gewicht des verarbeiteten Fleisches: ...	
aus Schusswunde: Hautschuss	



Game origin certificate/Sample certificate

Age: 0 – 3 years





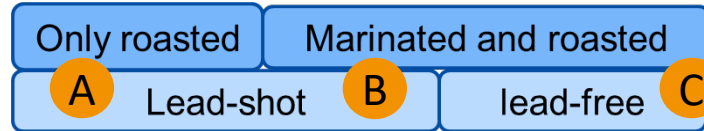
Parts

- Shoulder
- Saddle
- Haunch
- edible meat from near the wound channel (20 cm around the previously removed wound channel)

Kitchen preparation

Preparation of feeding portions for the feeding trial with pigs

- Separately for every part → three variations:



- Preparation of a marinade (*pickle*): ¼ litre cider vinegar, ½ litre red wine, ½ litre water
 - pickled meat was marinated for 24 hours at +7°C
 - meat → roasted, deglazed with water and wine (defined quantity) and salted
 - Homogenization of meat and sauce

pickling causes pH value decrease: 6.64 vs. 5.58 (p < 0.05)



Lead analysis



Measurement of lead content via microwave digestion and ICP-MS [mg/kg]

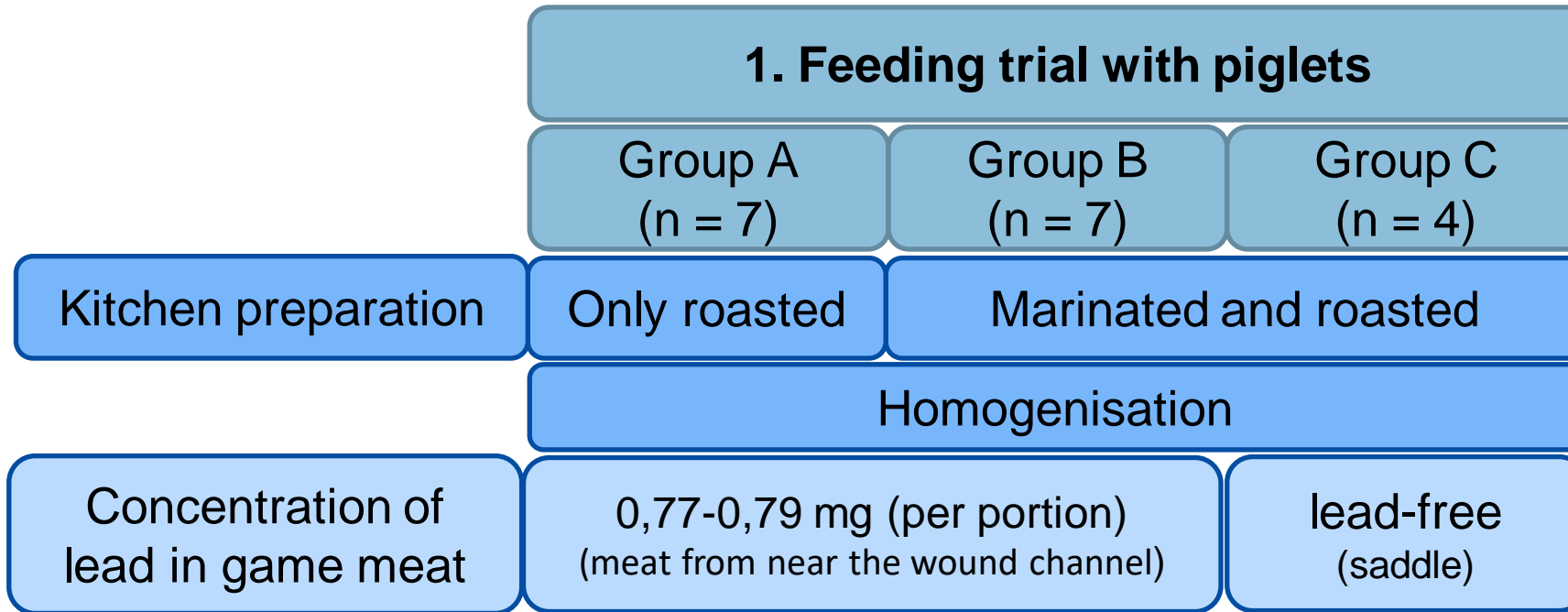
Sample side	Ammunition	Kitchen preparation	
		Cooked	Marinated + cooked
Near wound channel	Lead	2.17	0.54
Saddle	Lead-free		<0.02

} Used during Feeding trail

Schulz et al., 2021

Feeding trial with pigs

Schematic diagram of the experimental setup



Game meat portion was **applied once**, for:

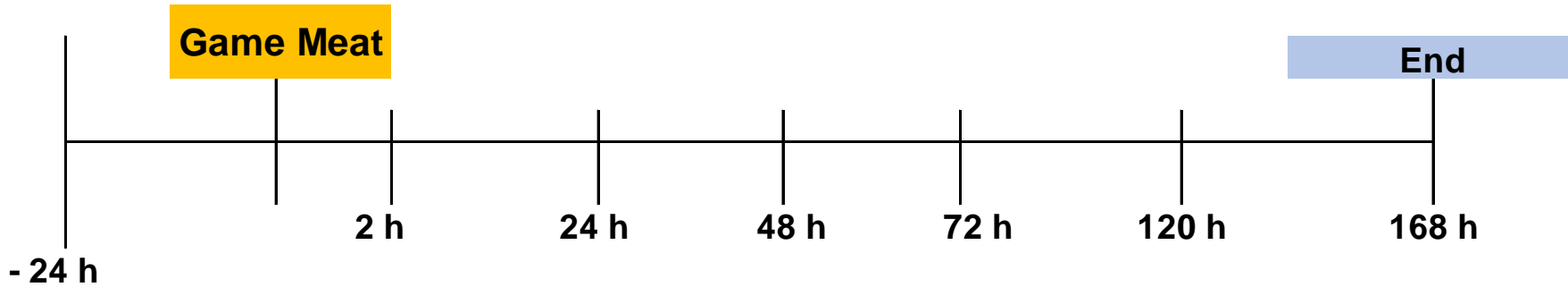
Group A: 355 g

Group B: 1470 g (offend in several smaller portions of 300-350 g) → Pigs of Group B fed just 1200 g of game meat

Group C: 450 g

→ 0,65 mg lead/portion

Blood sampling & Calculations



Statistical analysis via IBM SPSS Statistics 21

- Multivariate Linear Model
- normal distribution test:
Kolmogorov–Smirnov test
- significance level: $P < 0.05$

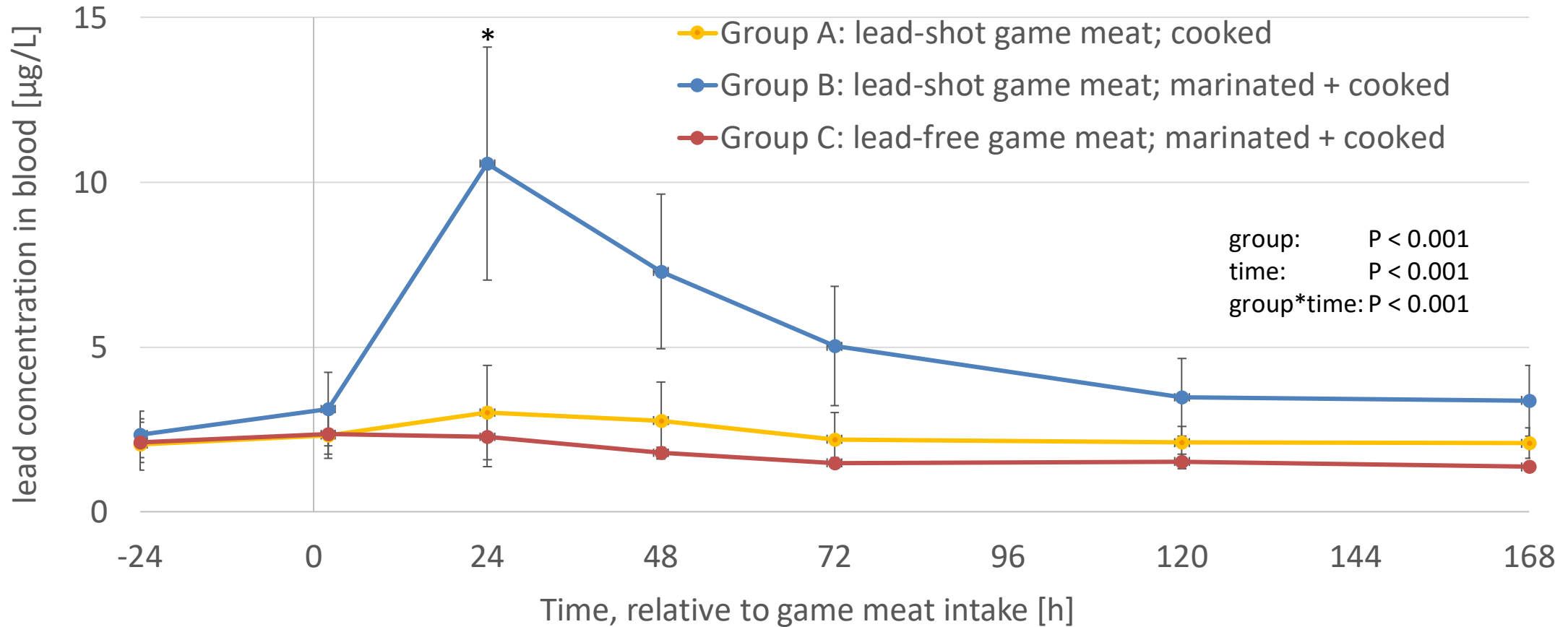
The area under the curve (AUC) was calculated using the linear trapezoidal rule:

$$AUC = \sum_{n=1}^N \frac{C_n + C_{n+1}}{2} (t_{n+1} - t_n)$$



The absolute bioavailability F was calculated:


$$f = \frac{AUC_{post\ oral} * Dosis_{i.v.}}{AUC_{i.v.} * Dosis_{post\ oral}} * 100$$

Results – Blood concentrations of Feeding groups (mean ± SD)



Results – Absolute bioavailability of lead residues

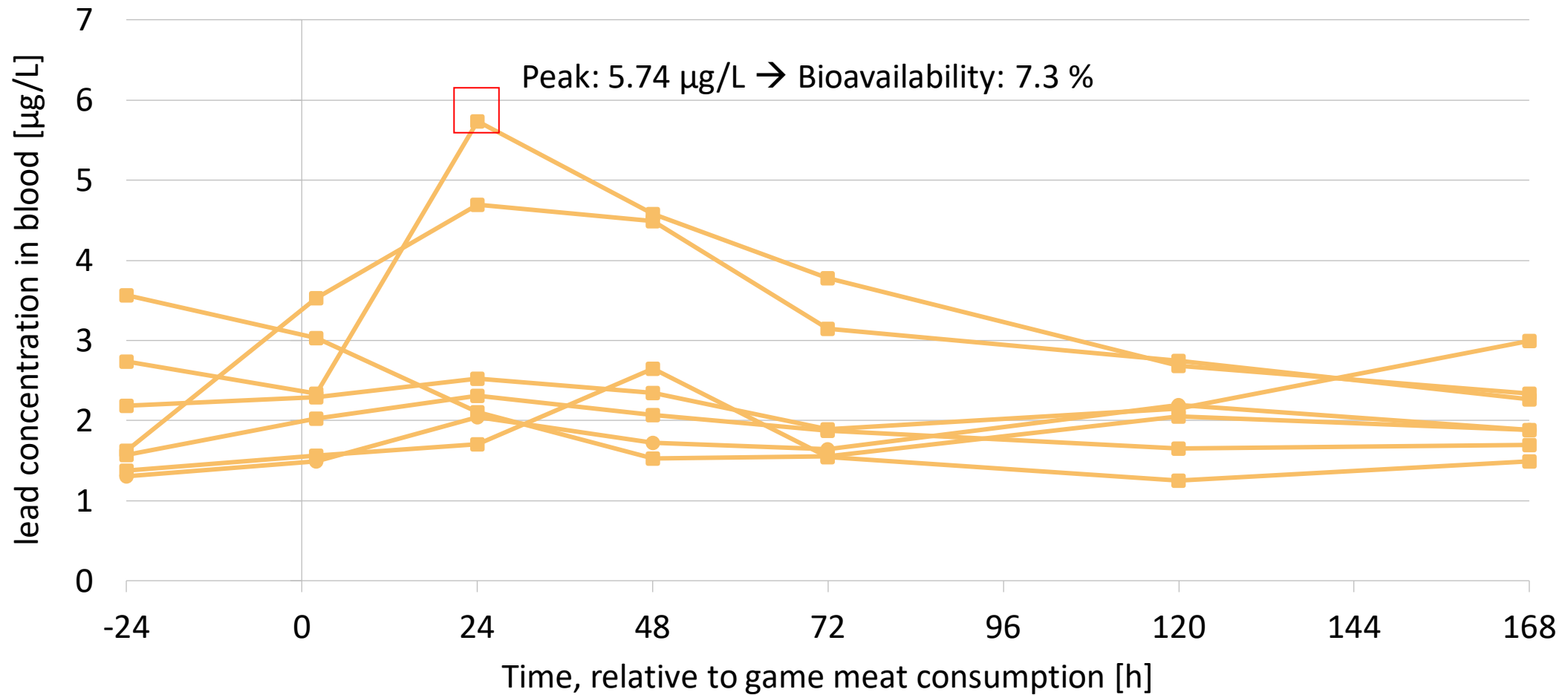
Treatment		AUC	Absolute bioavailability (%)
Group A Game meat only roasted		106.9	2.7
Group B Game meat marinated & roasted		500.6	15.0


5.5 times higher

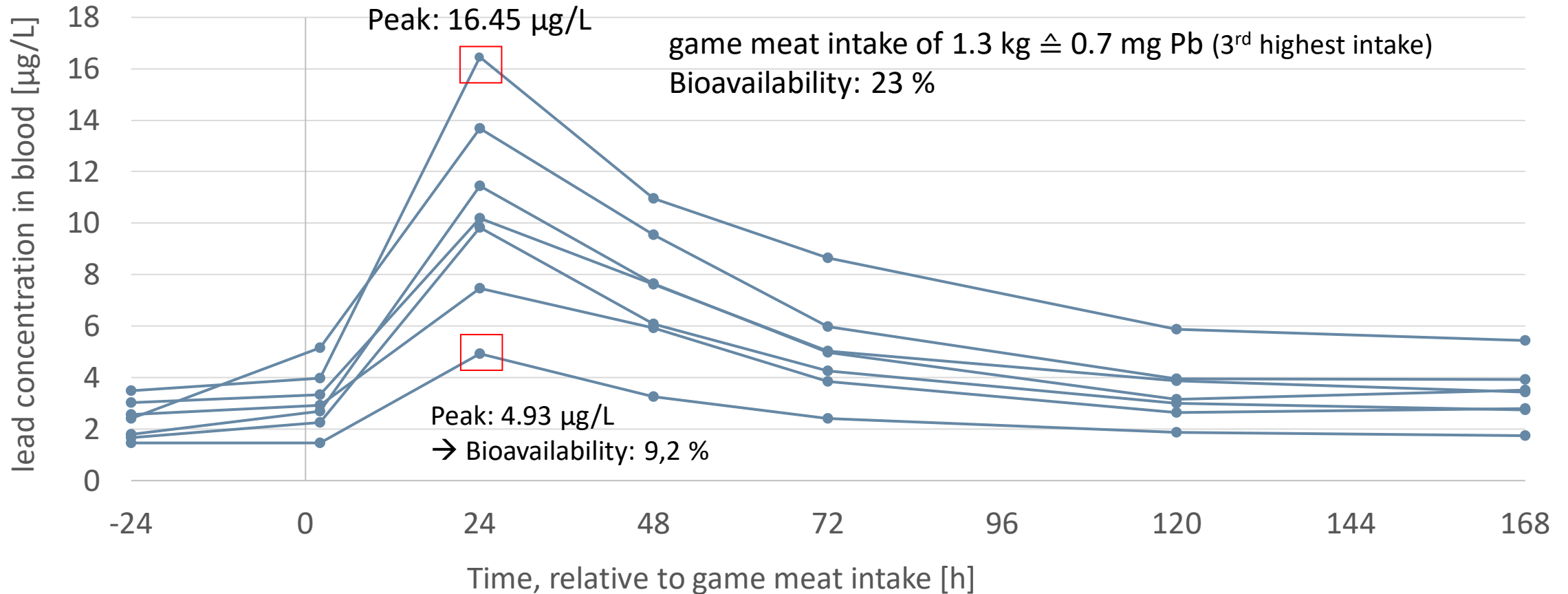


Mateo et al., 2011
Range of bioavailability: 0.7 – 6.75 %

Results – individual blood concentrations in pigs of Group A (only roasted)



Results – individual blood concentrations in pigs of Group B (marinated & roasted)



Conclusion



- Residues of ammunition lead are bioavailable
- Acidic marination increases lead bioavailability
- Obviously, lead particles of different sizes were distributed inhomogeneously
- Use of leadfree hunting ammunition has to be preferred in the light of the toxicity of lead



Bundesinstitut für Risikobewertung

RESEARCH ARTICLE

Marination increases the bioavailability of lead in game meat shot with lead ammunition

Kirsten Schulz^{1*}, Franziska Brenneis¹, Richard Winterhalter² , Markus Spolders¹, Hermann Fromme³, Silvio Dietrich², Petra Wolf⁴ , Carl Gremse¹, Helmut Schafft¹, Robert Pieper¹ and Monika Lahrssen-Wiederholt¹

¹*Department of Safety in the Food Chain, German Federal Institute for Risk Assessment, 10589 Berlin, Germany*

²*Department of Chemical Safety and Toxicology, Bavarian Health and Food Safety Authority, 80538 Munich, Germany*

³*Ludwig-Maximilians-University, Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine, 80336 Munich, Germany*

⁴*Department of Nutritional Physiology and Animal Nutrition, University of Rostock, 18059 Rostock, Germany*

(Received 16 December 2020 – Final revision received 1 March 2021 – Accepted 5 March 2021)

Journal of Nutritional Science (2021), vol. 10, e24, page 1 of 9

doi:10.1017/jns.2021.15

Thank you for your attention

Dr. Kirsten Schulz
T +49 30 18412-28412
Kirsten.schulz@bfr.bund.de

Bundesinstitut für Risikobewertung
bfr.bund.de


BfR | Risiken erkennen –
Gesundheit schützen

Verbraucherschutz zum Mitnehmen

BfR2GO – das Wissenschaftsmagazin des BfR


bfr.bund.de/de/wissenschaftsmagazin_bfr2go.html

Folgen Sie uns

 @bfrde | @bfren | @Bf3R_centre

 @bfrde

 youtube.com/@bfr_bund

 social.bund.de/@bfr

 linkedin.com/company/bundesinstitut-f-r-risikobewertung

Quellenverzeichnis

1. Green RE, Pain DJ (2019) Risks to human health from ammunition-derived lead in Europe. *Ambio*
2. Haldimann M, Baumgartner A, Zimmerli B (2002) Intake of lead from game meat – a risk to consumers' health? *European Food Research and Technology* 215, 375-379.
3. Kollander B, Widemo F, Ågren E *et al.* (2017) Detection of lead nanoparticles in game meat by single particle ICP-MS following use of lead-containing bullets. *Anal Bioanal Chem* 409, 1877-1885.
4. Mateo R, Baos AR, Vidal D *et al.* (2011) Bioaccessibility of Pb from ammunition in game meat is affected by cooking treatment. *PLoS One* 6, e15892.
5. Hunt WG, Watson RT, Oaks JL *et al.* (2009) Lead bullet fragments in venison from rifle-killed deer: potential for human dietary exposure. *PLoS One* 4, e5330.