

Transfer studies on contaminants in food producing animals

Ron Hoogenboom



RIKILT

WAGENINGEN UR

Contaminants potentially present in feed

- Different classes
 - Mycotoxins
 - Plant toxins
 - Heavy metals
 - Persistent organic pollutants
 - Pesticides
 - Antibiotics
 -
- For part of these compounds product limits

Transfer

- Most compounds easily metabolized and/or excreted
 - Sometimes toxic metabolites
- Some are persistent and excreted/accumulated in animal derived products
 - Certain dioxins and PCBs
 - Certain brominated flame retardants
 - Certain organochlorine pesticides
 - Perfluorinated alkanes (PFOS/PFOA)
 - Some heavy metals

Sources

- Feed
- Water
- Soil
- Bedding
- Building materials



Typical questions related to transfer

- Does transfer result in a risk for consumers?
 - Parent compound and metabolites
- Which feed levels ensure compliant food?
- In case of incidents
 - If food limits are exceeded which feed level?
 - How long before foodlevels are below limits?
- Various studies performed
 - Some examples

Set-up of studies

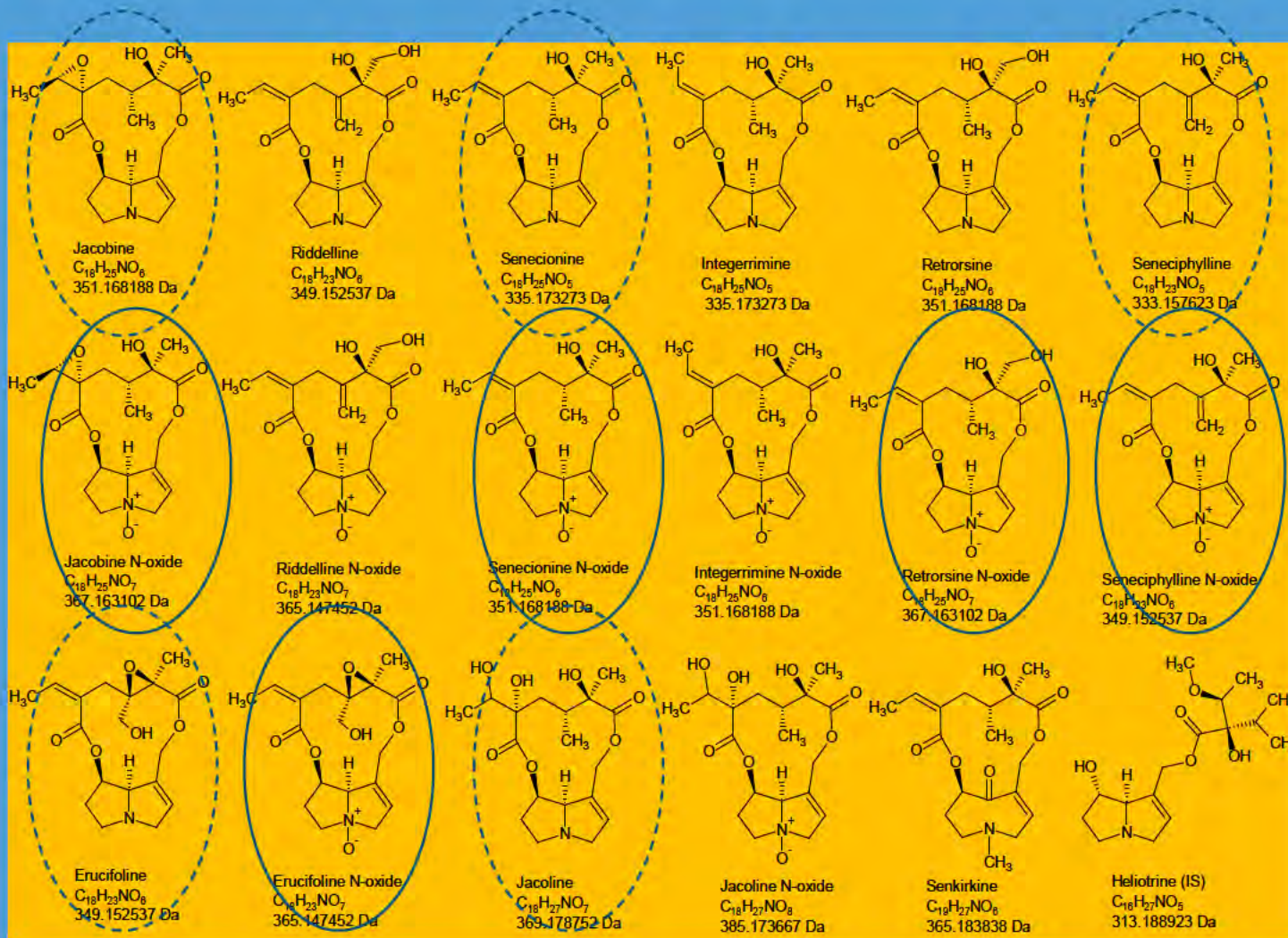
- Which questions?
- Common issues
 - Which feed levels?
 - Which animal species?
 - Which tissues to sample/analyze?
 - Also blood?
 - Also urine, feces?
- Which time points?

Pyrrolizidine alkaloids, an increasing problem?

- Risk for animals
 - Direct consumption
 - Presence in feed
- Potential risk for consumers
 - Contamination of honey
 - Presence in rocket salad
 - Herbs/tea
 - **Contamination of milk and meat**



Structures of pyrrolizidine alkaloids



Properties of PAs

- Effects on the livers (veno-occlusive disease)
- Causing liver tumours
 - Formation of DNA adducts
 - Genotoxic properties
- Therefore regarded as genotoxic carcinogens: no threshold
 - Low levels may cause effects

Animal feedstuffs: Alfalfa (lucerne)



	2006	2007	2008	2009	2010	2011	2012
No of samples	6	13	12	17	51	50	51
Positive	83%	85%	83%	88%	92%	86%	90%
Average content (µg/kg)	1440	225	716	621	225	265	356
Max (µg/kg)	3439	1409	6219	4507	2418	2027	4169
Samples >1000 µg/kg	3 (50%)	1 (8%)	1 (8%)	2 (12%)	4 (8%)	4 (8%)	6 (12%)

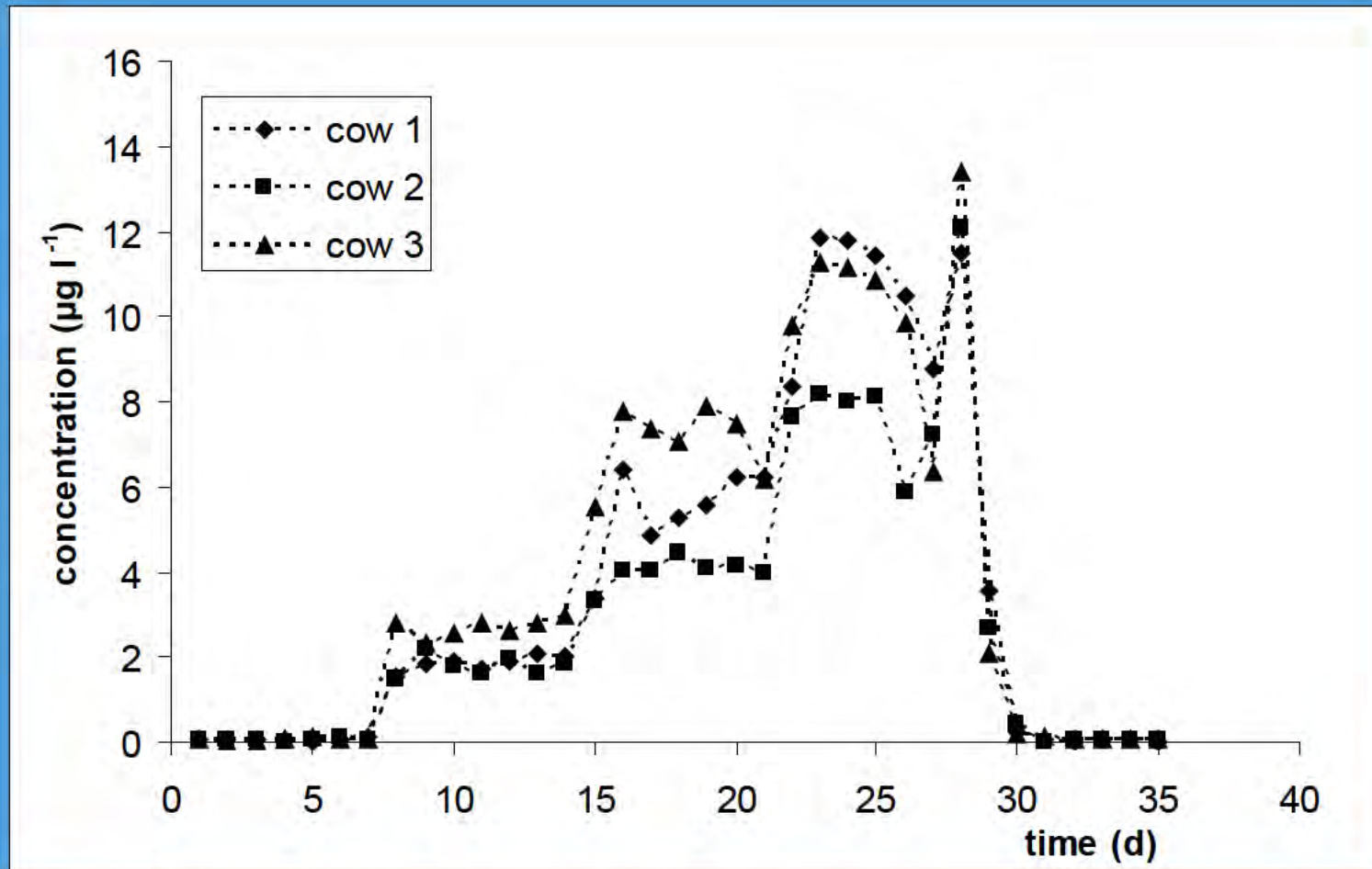
- In the Netherlands contamination of alfalfa with PAs remains high, notwithstanding the information provided to the industry

Transfer to milk: study design

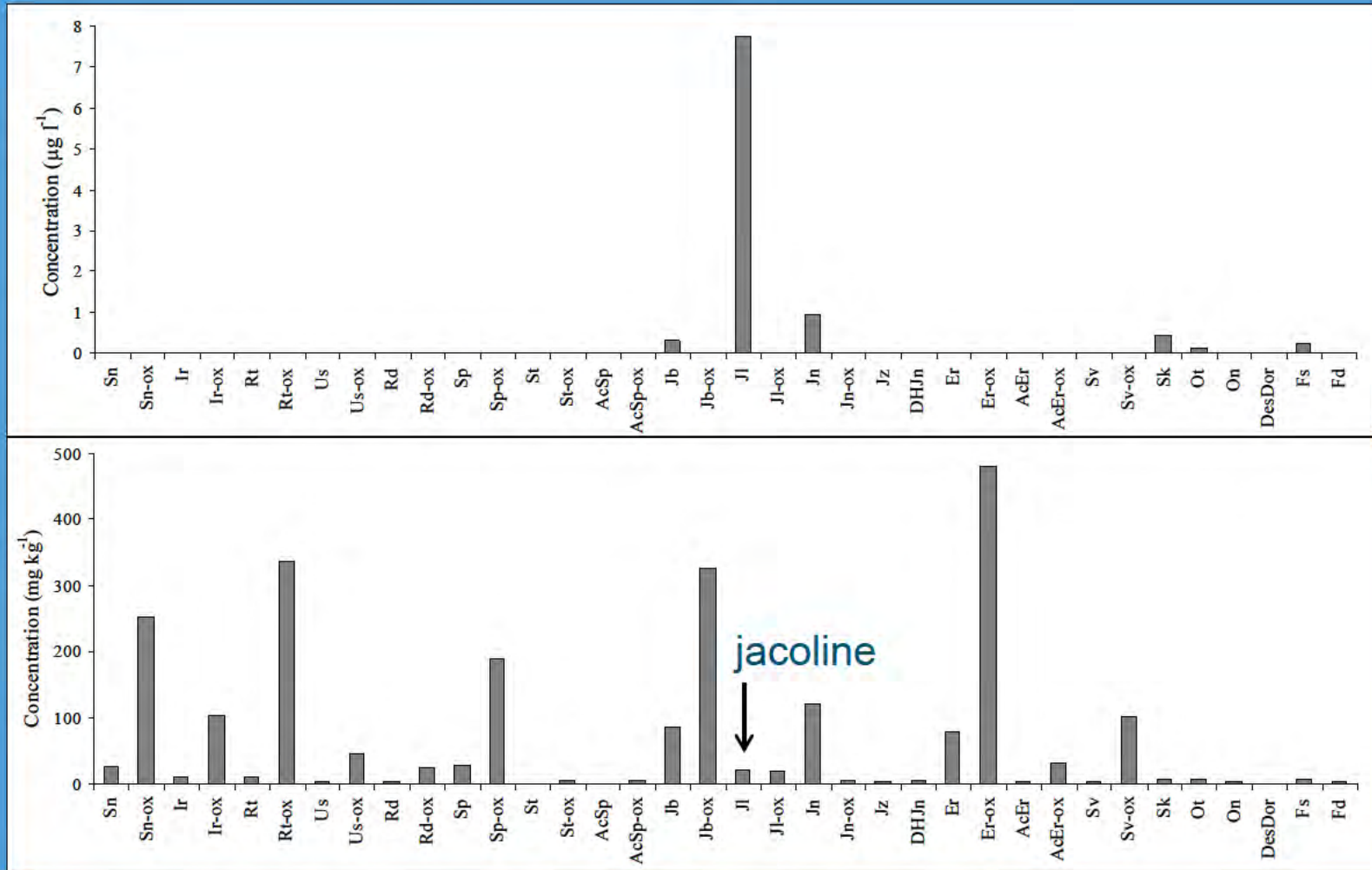
- 3 cows fed (fistula) 2x/day with tansy ragwort (*Senecio jacobaea*)
 - Week 1: no ragwort
 - Week 2: 2x 25 g ragwort
 - Week 3: 2x 50 g ragwort
 - Week 4: 2x 100 g ragwort (1% of feed intake)
 - Week 5: no ragwort
- Collected:
 - Milk
 - Some urine and feces



PAAs in evening milk



Milk versus plant material



Conclusions and remaining questions

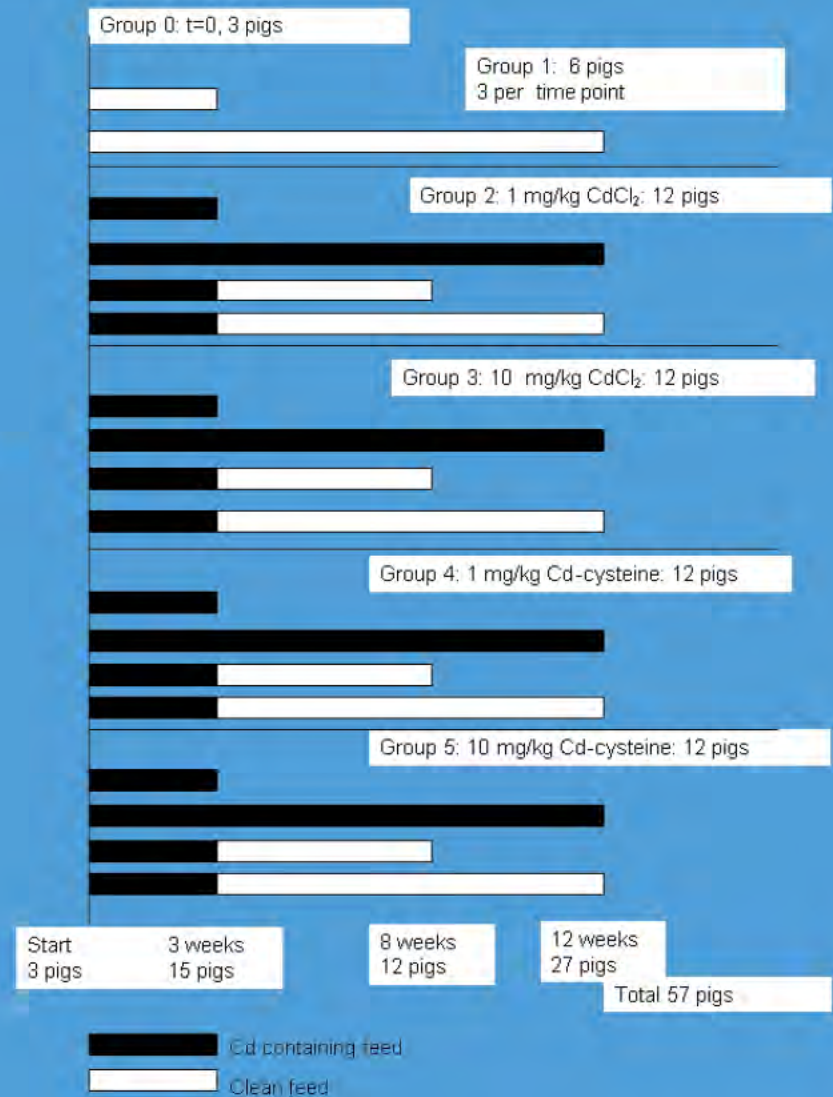
- Overall low transfer: 0.1% but higher for eg jacoline
 - Still in $\mu\text{g/l}$ range and potentially relevant
- Carcinogenic potency of jacoline unknown
 - If similar to others, potential risk for the consumer
- Urine/feces: poor balance, meaning the formation of unknown metabolites
 - Additional risk, if transferred to milk?

Heavy metals

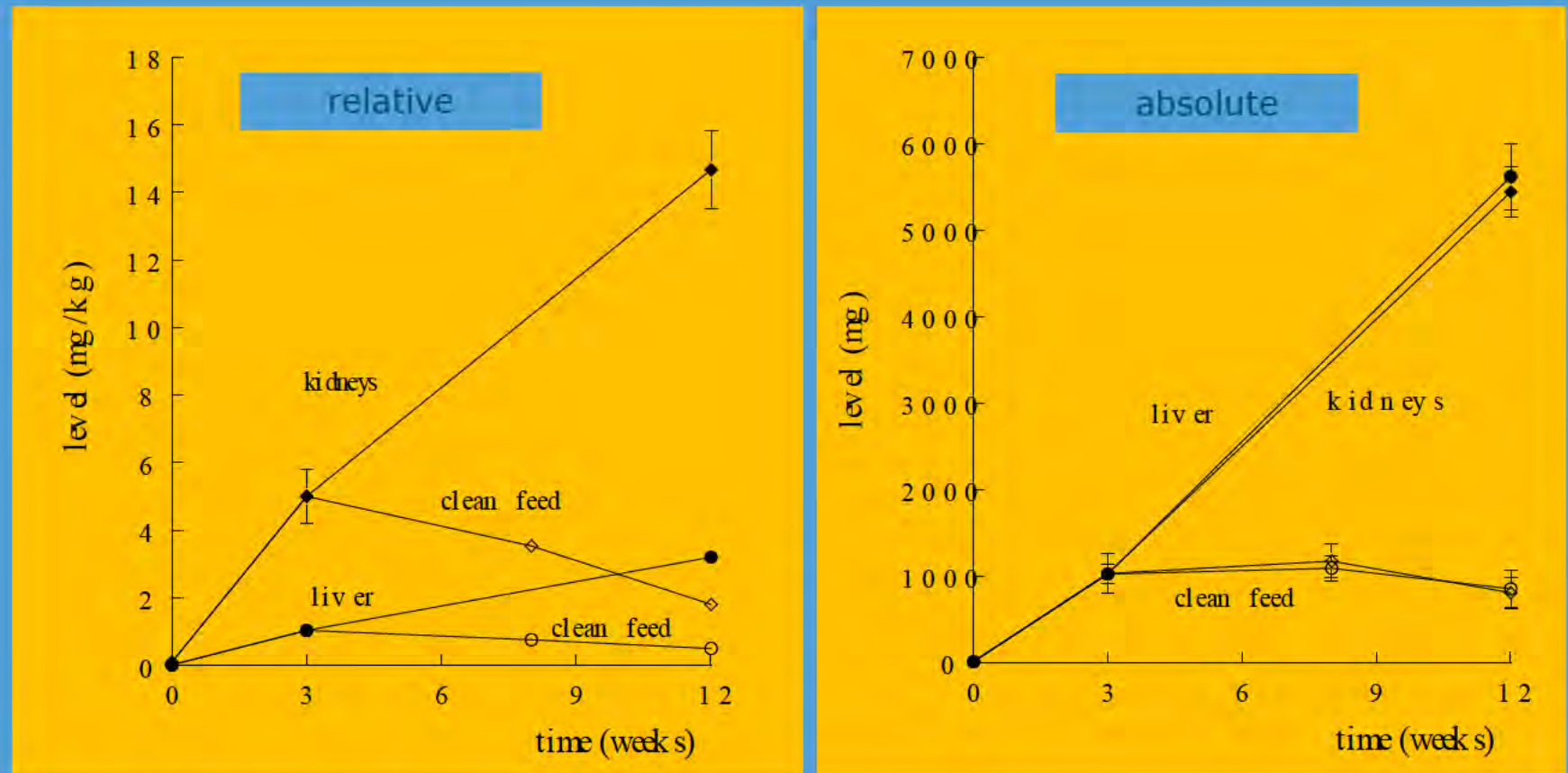
- Occasionally elevated levels in feed (materials) or soil
- Some accumulate in the animals
 - E.g. cadmium in livers and kidneys
- Study performed with pigs

Exposure scheme

- Levels of 0, 1 and 10 mg Cd/kg feed (EU-ML 0.5)
- For 3 and 12 weeks
- Also put on clean feed after 3 weeks



Cd levels kidneys and livers (10 mg/kg feed)



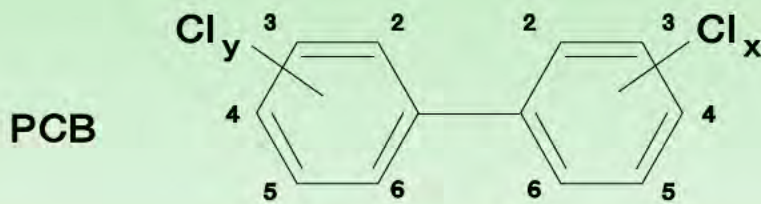
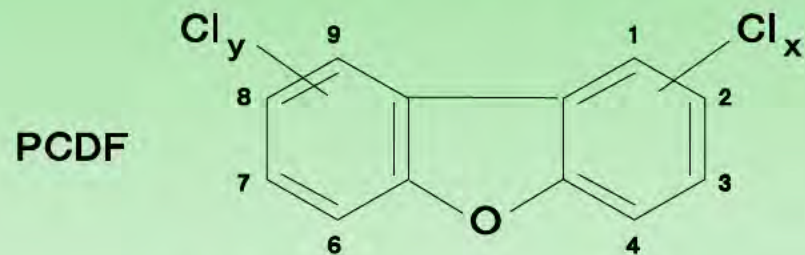
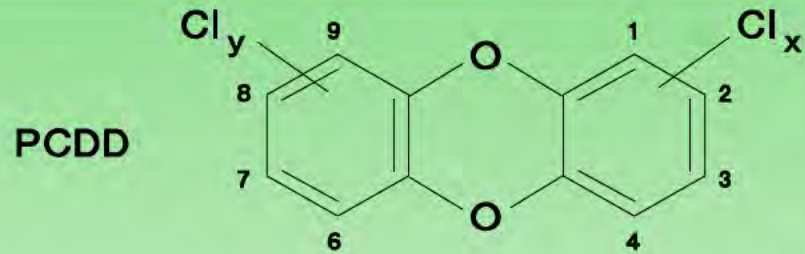
EU-MLs: 1.0 (kidneys) and 0.5 (livers) mg/kg

Conclusions

- Decrease in levels after ending exposure primarily due to increase in organ weights
- No clear migration of cadmium from liver and kidney
- In growing pigs EU-limits for cadmium in feed ensure that levels in kidneys and livers do not exceed the MLs



Dioxins and PCBs



Feed related incidents

Ball clay US 1998

Brazilian citrus pulp 1998

Belgian PCB fat 1999

German kaolinic clay 1999

Belgian cholin chloride 2002

German bakery waste 2003

Potato peels/kaolinic clay 2004

Gelatin fat/Hydrochloric acid 2006

Minerals (Zinc) Chile 2008

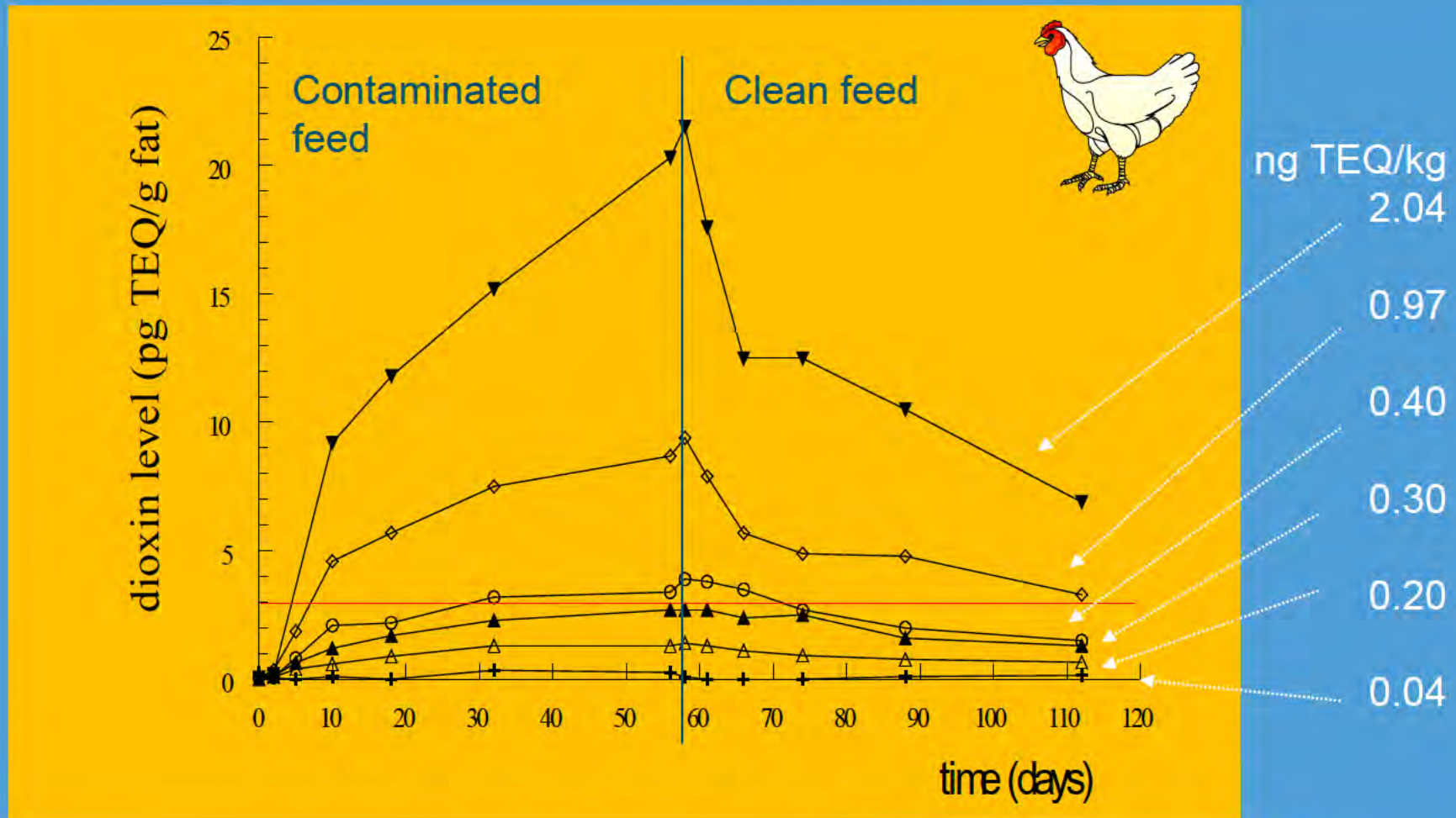
Bakery waste Ireland 2008

Organic corn Ukraine 2010

Fatty acids Germany 2011

*Eggs from free-range hens
Sheep livers*

Transfer of dioxins from feed to eggs



Conclusions transfer in laying hens

- Low levels in feed cause levels in eggs to exceed the MLs
 - At steady state 40% of dioxins/PCBs in feed (100 g/day) go to eggs (5 g fat)
- Similar transfer with dioxins and PCBs from soil

Elevated dioxins and PCBs in sheep livers

- More than 50% of the livers exceed the EU-ML
- Levels in meat and fat normally OK
- Most sheep forage outside, winter and summer
 - Although males often slaughtered in autumn
 - Dioxin levels in winter grass relatively high
- Little insight in relation dioxin intake vs levels in meat and liver

Carry-over study with sheep



- Study with blackhead sheep performed by BfR Berlin
- Sheep fed with contaminated grass followed by clean grass (contaminated grass from flood plain near IJssel river)



RIKILT

WAGENINGENUR

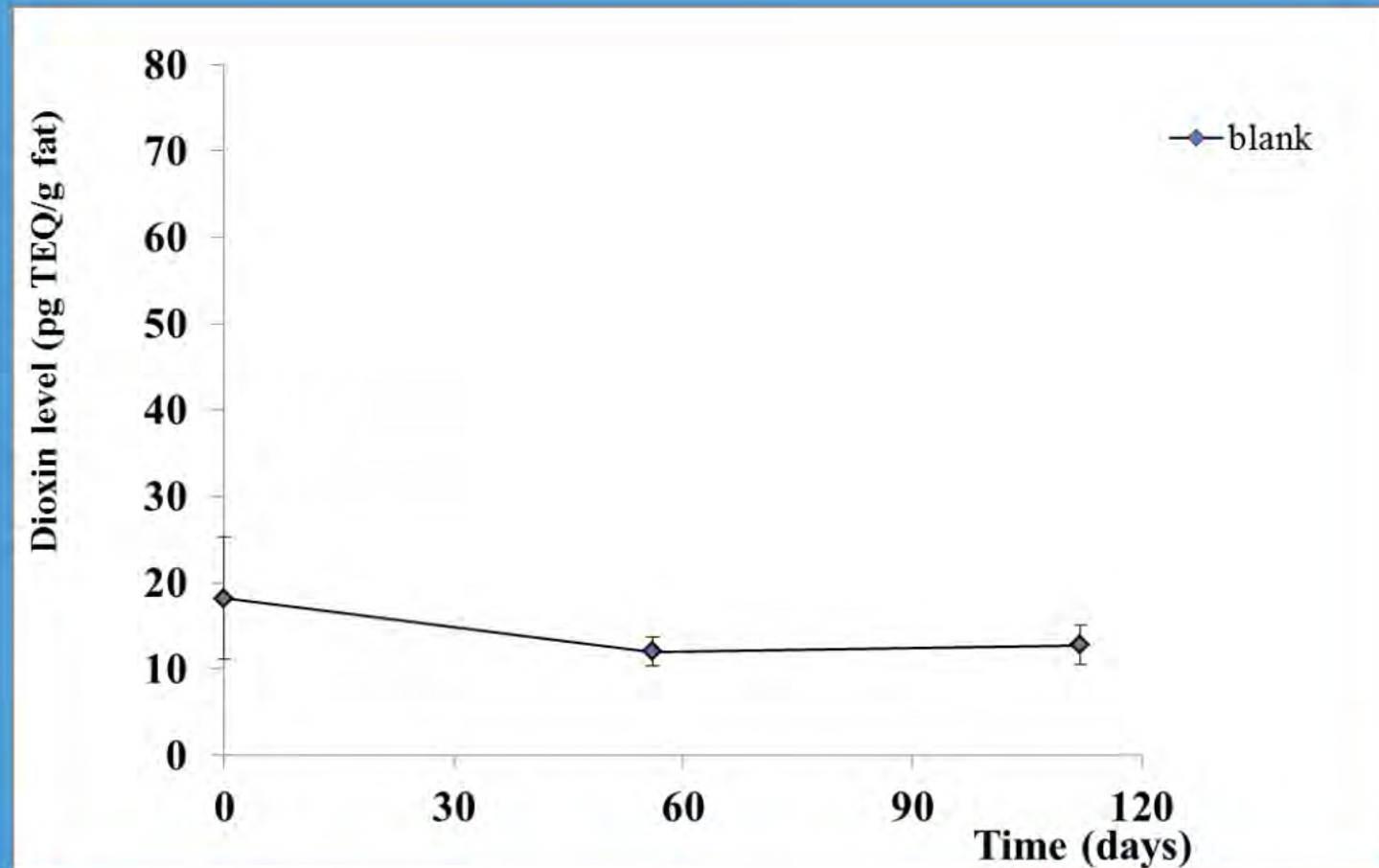
Name of the event, venue, date

Grass

	Dioxins pg TEQ/g dm	dl-PCBs pg TEQ/g dm	Sum pg TEQ/g dm	ndl-PCBs µg/kg dm
Clean	0.27 (0.26)	0.06 (0.06)	0.33 (0.32)	0.45 (0.45)
Contaminated	1.71 (1.71)	0.32 (0.32)	2.04 (2.02)	2.33 (2.33)

- EU-ML: 0.75/1.25 ng TEQ/g dm, 10 µg/kg dm for ndl-PCBs
- Focus on results dioxins

Dioxins in liver (blank)



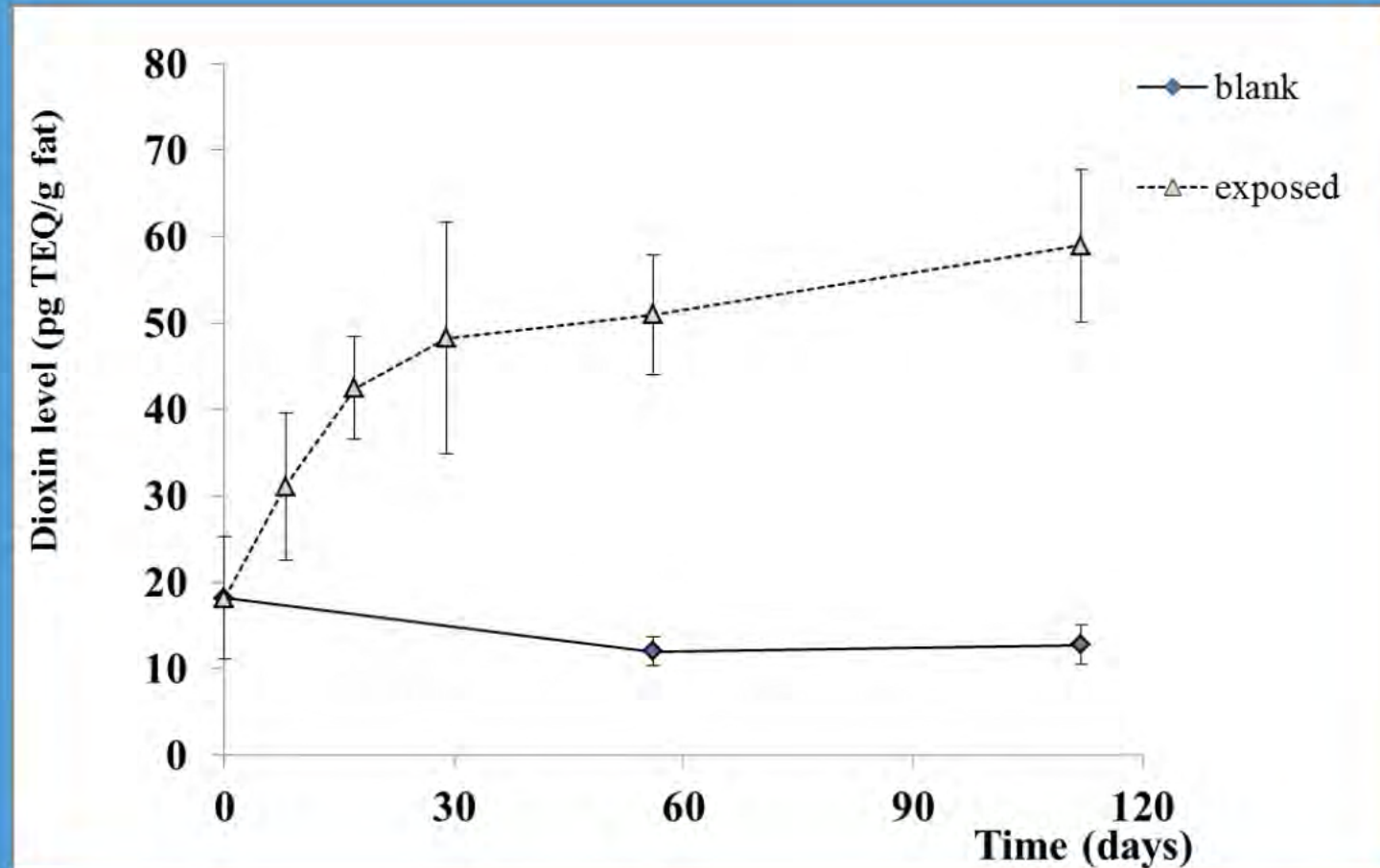
EU-ML liver 4.5 pg TEQ/g fat



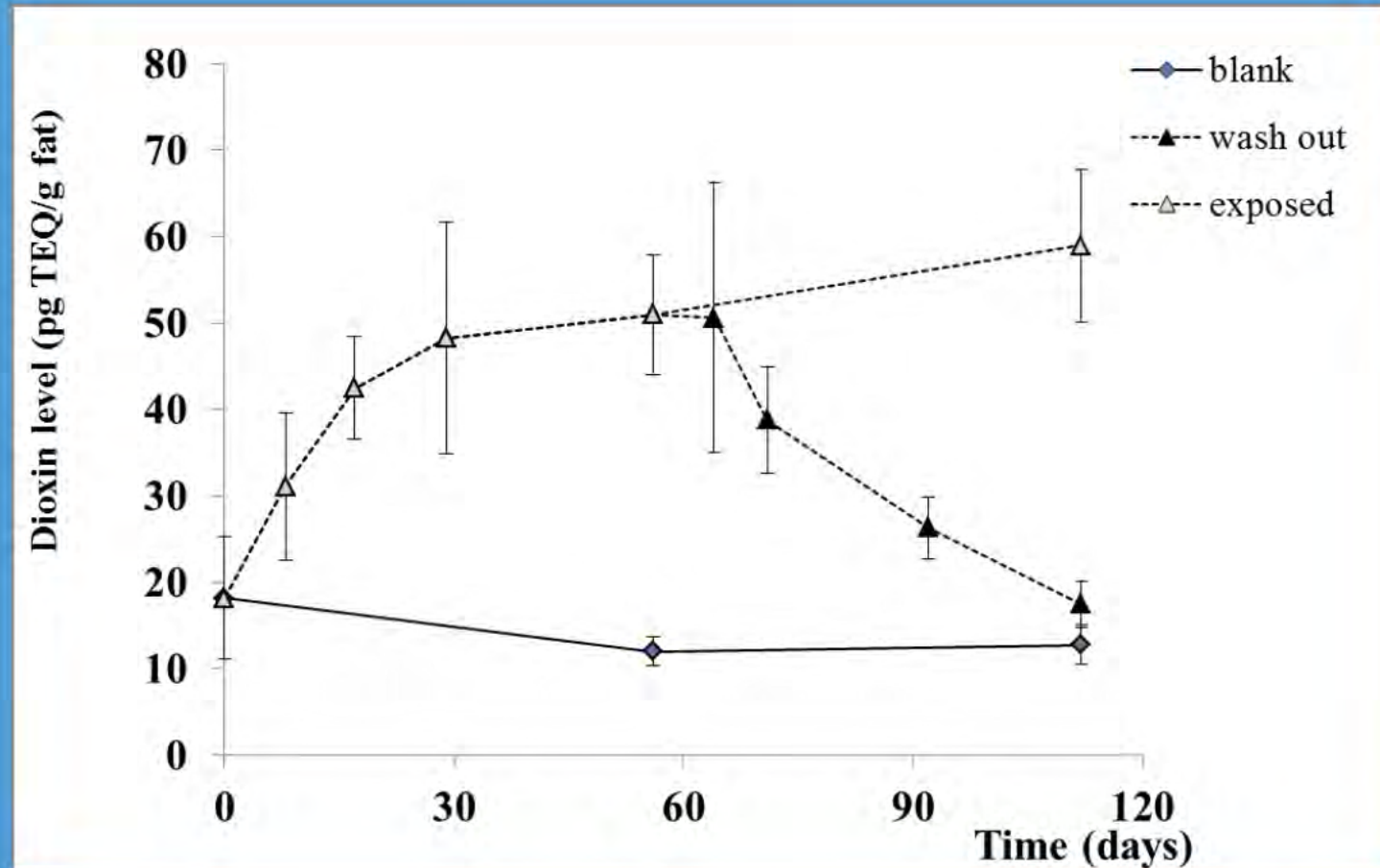
RIKILT

WAGENINGEN UR

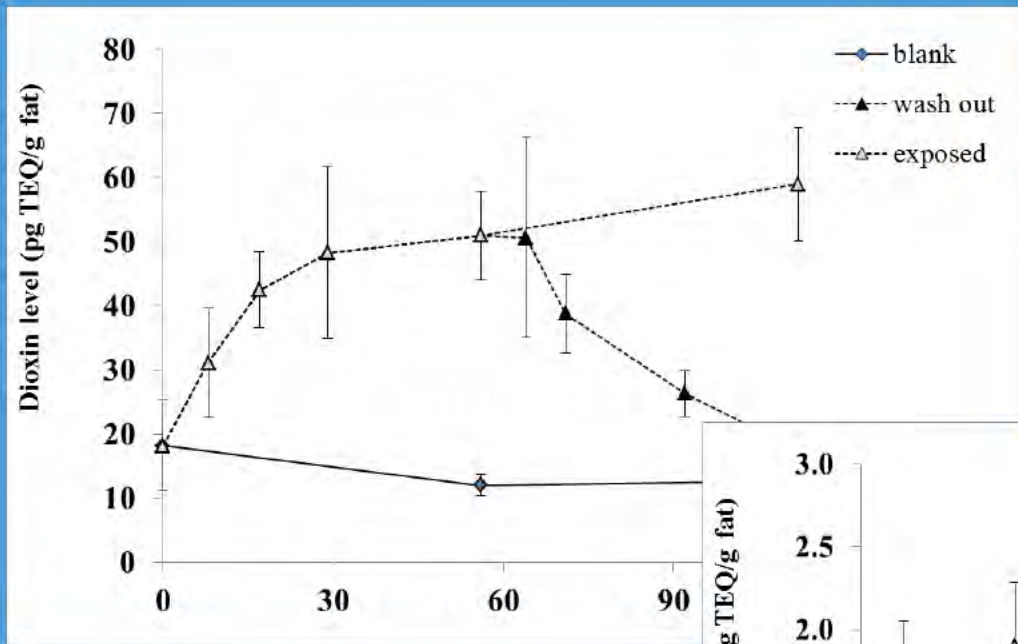
Dioxins in liver (exposed for 112 d)



Dioxins in liver (wash-out after 56 days)

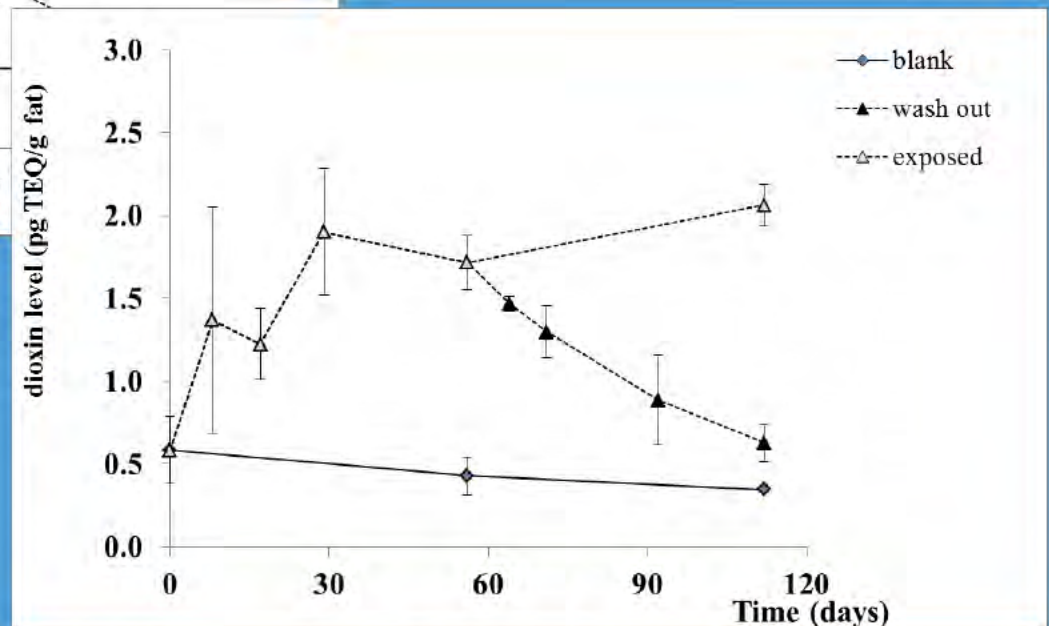


Dioxins in livers versus kidney fat



Levels in liver on lipid base 30 times higher

EU-MLs liver 4.5, fat 2.5 pg TEQ/g fat



Conclusions

- Dioxins accumulate selectively in the liver
 - Increase with higher chlorination
- High levels observed in livers even at this “low” exposure
- Strong decrease when exposure is terminated
 - Possible solution to lower the levels and as such the exposure of consumers
 - Feasible in practice?

Modelling

- (How) can these data be used to build models?
- Important tools for risk assessment and risk management

Thank you for
your attention

Questions?



RIKILT

WAGENINGENUR