



# Controls on bioaccessibility of organics – what do we know.

Chris Collins

# Why do we do bioaccessibility tests?



**The Telegraph**

HOME NEWS WORLD SPORT FINANCE COMMENT BLOGS CULTURE

Women Motoring **Health** Property Gardening Food History


Health News Health Advice Diet and Fitness Wellbeing Expat H

HOME » HEALTH » HEALTH NEWS

## Allotments really are good for your health

Keeping an allotment really is good for your health, the first study to directly has found.

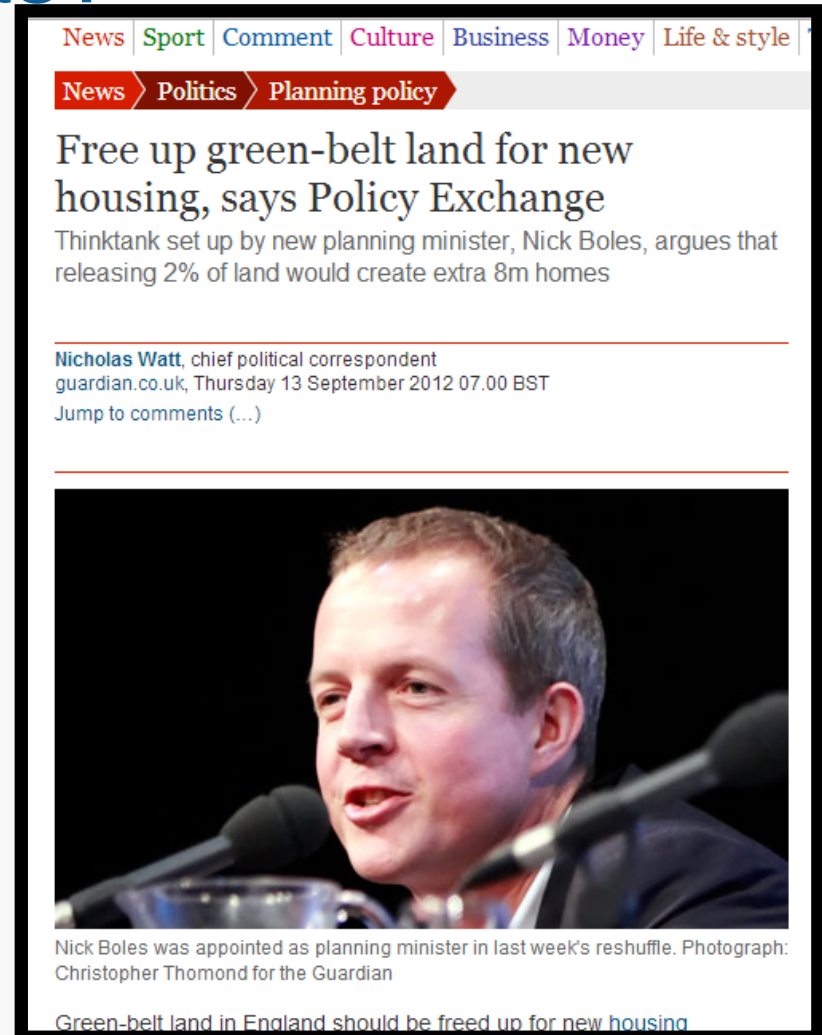
By **Stephen Adams, Medical Correspondent**  
6:30AM GMT 23 Nov 2010

 **Follow** 1,576 followers

1 Comment

Dutch researchers have found that allotment keepers in their 60s tend to be significantly healthier than their more sedentary neighbours.

While plenty of anecdotal evidence exists to suggest growing one's own fruit and vegetables protects against ill-health, no one had carried out such a direct comparison before.




News Sport Comment Culture Business Money Life & style

News Politics **Planning policy**

## Free up green-belt land for new housing, says Policy Exchange

Thinktank set up by new planning minister, Nick Boles, argues that releasing 2% of land would create extra 8m homes

**Nicholas Watt**, chief political correspondent  
guardian.co.uk, Thursday 13 September 2012 07.00 BST  
[Jump to comments \(...\)](#)



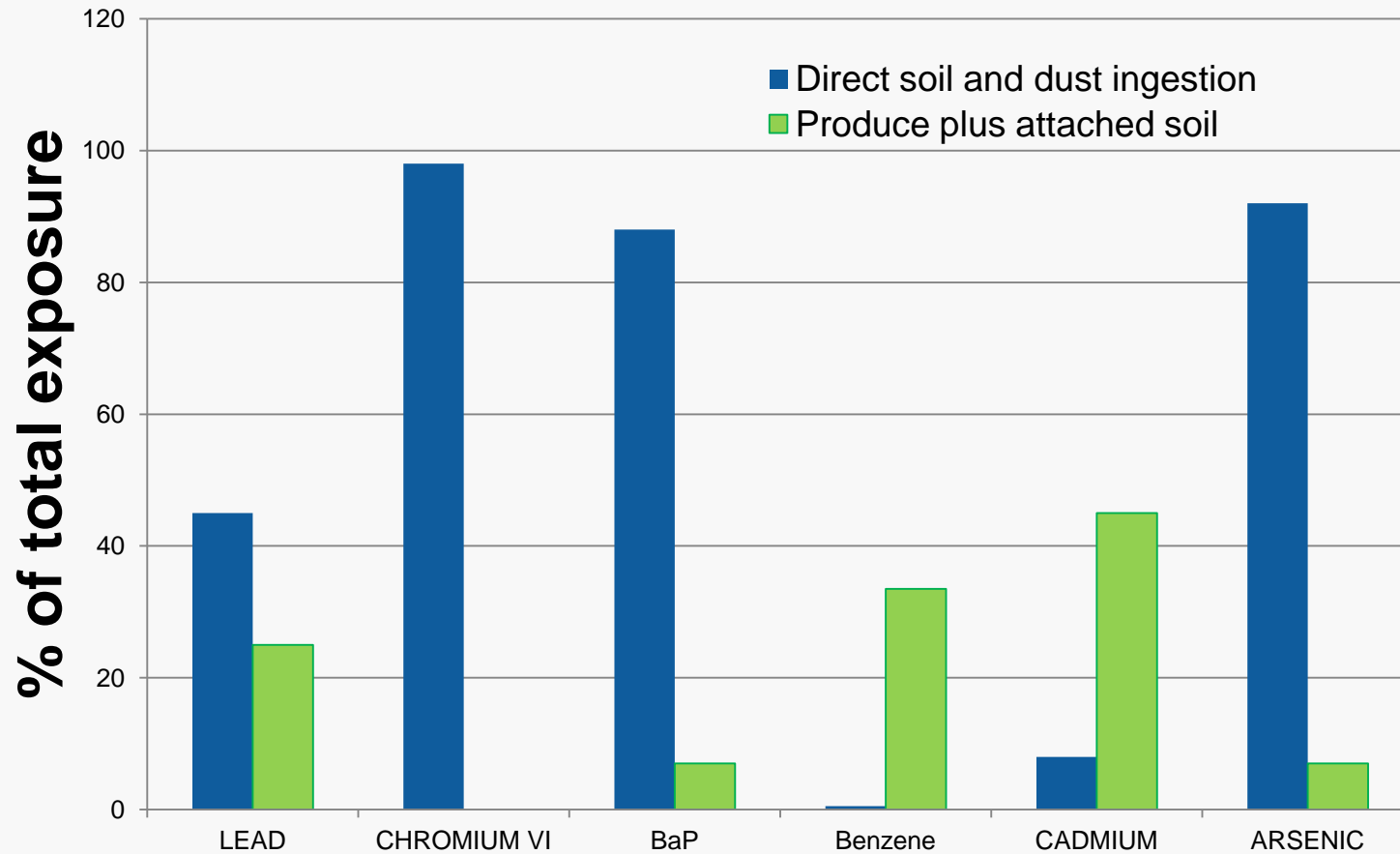
Nick Boles was appointed as planning minister in last week's reshuffle. Photograph: Christopher Thomond for the Guardian

[Green-belt land in England should be freed up for new housing](#)

# Why do we do bioaccessibility tests?

- Fine tune risk assessments of human exposure
- Reliance on total contaminant soil concentrations is likely to over-estimate risks, resulting in unnecessary determinations and remediation.
- Ingestion dose for most contaminants of concern is the dominant pathway under new CAT4 guidelines in UK

# Ingestion dominates the exposure pathway



# Where are we now ?

- ‘.... part of body of evidence....’

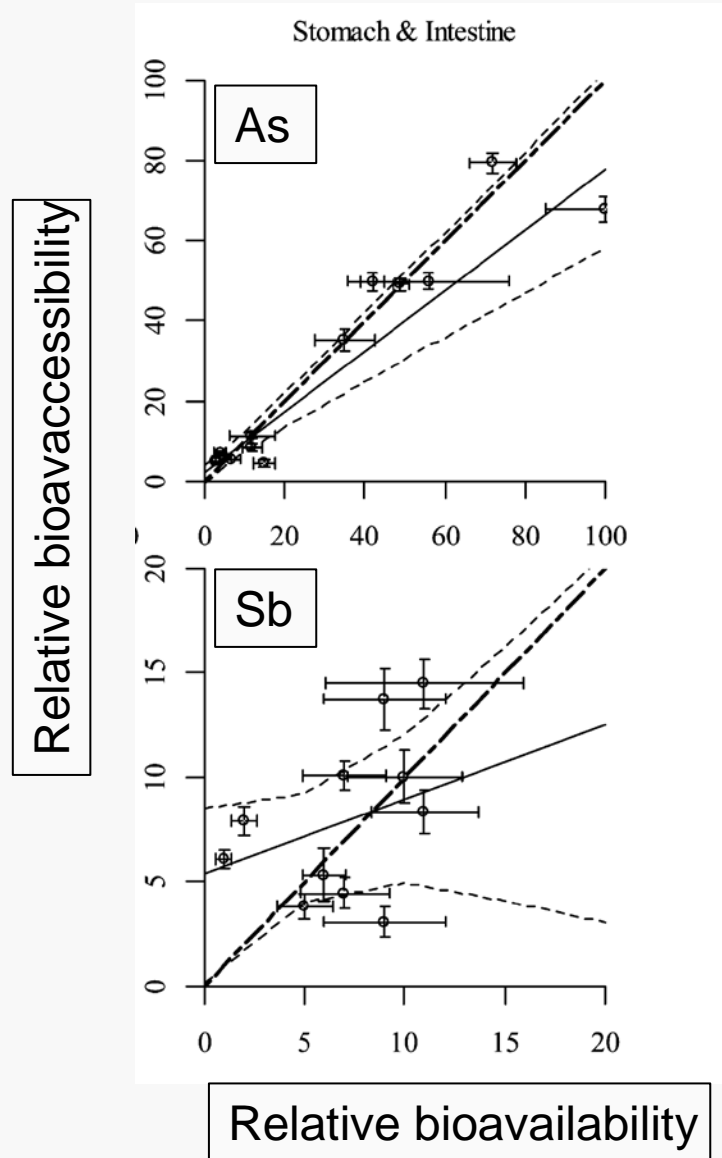
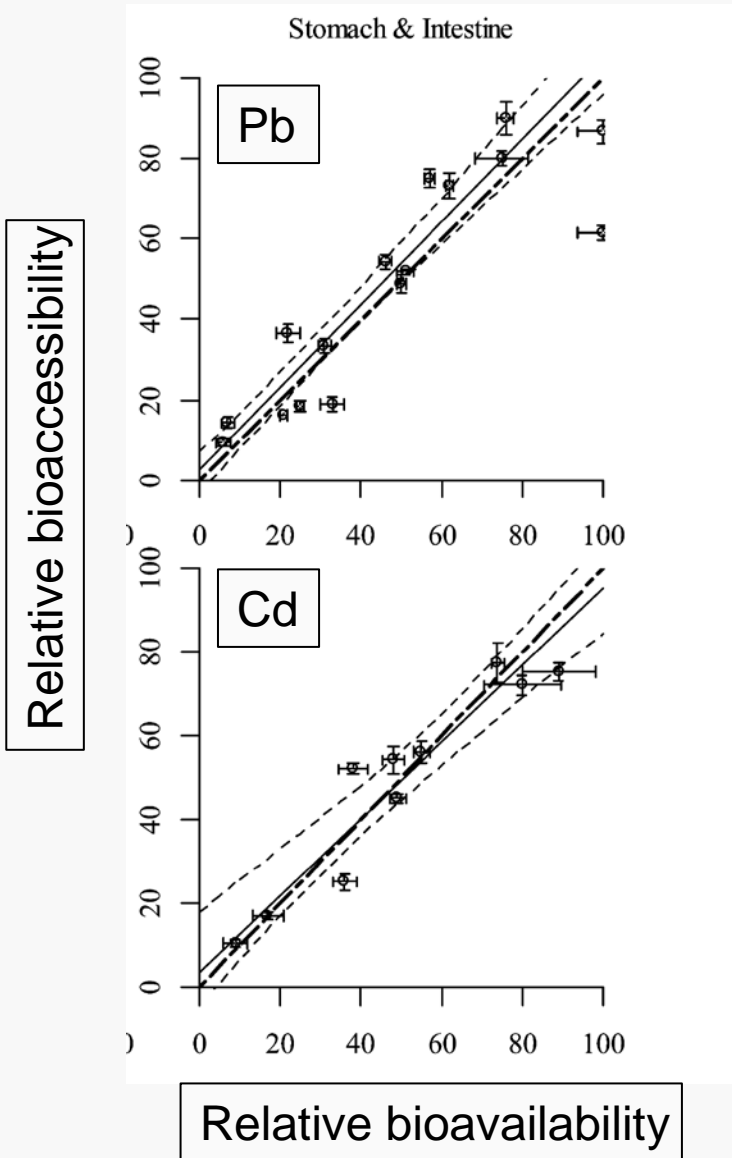
*EA, England and Wales*

- Flanders bioaccessibility HHRA for PAH
- ‘Careful use of oral bioavailability data in DQRAs can help clarify risks and has been supported by CLR’s but its limitations and uncertainties must be recognised.’

*CIEH, 2009*

- But generally applied for toxic elements. Even then regulatory guidance not complete.

# Toxic elements and UBM method



# What makes a robust and realistic test?

# What are the factors which determine an acceptable test?

## **BARGE (Bioaccessibility Research Group in Europe)**

- It should be physiologically based, mimicking the human GI physico-chemical environment in the stomach and small intestine (colon).
- It should represent a conservative case;
- There should be one set of conditions for all potentially harmful elements (PHE) being studied;
- It must be demonstrated that the test is a good analogue of in vivo conditions
- The test must be able to produce repeatable and reproducible results within and between testing laboratories.

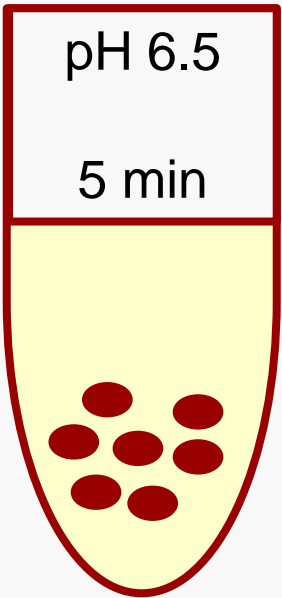


# Idealised physiologically based extraction test system

**Mouth**

pH 6.5

5 min

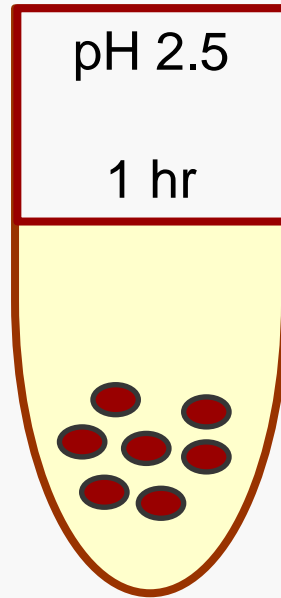


c.1g soil added to  
Saliva fluid.

**Stomach**

pH 2.5

1 hr

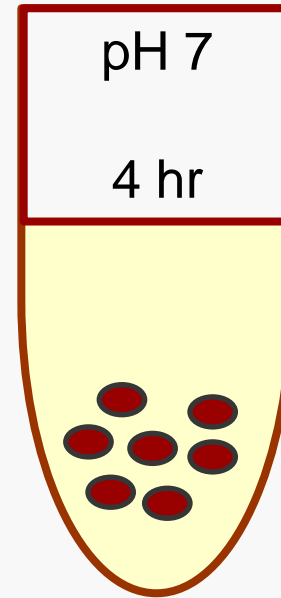


Add stomach  
medium (pepsin,  
NaCl, HCl).

**Small  
intestine**

pH 7

4 hr

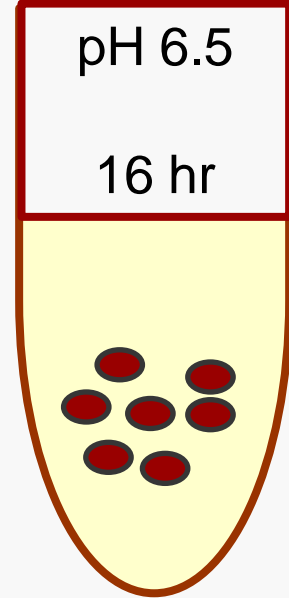


Add bile,  
pancreatin,  
adjust pH  
  
Add food  
components

**Colo**

pH 6.5

16 hr

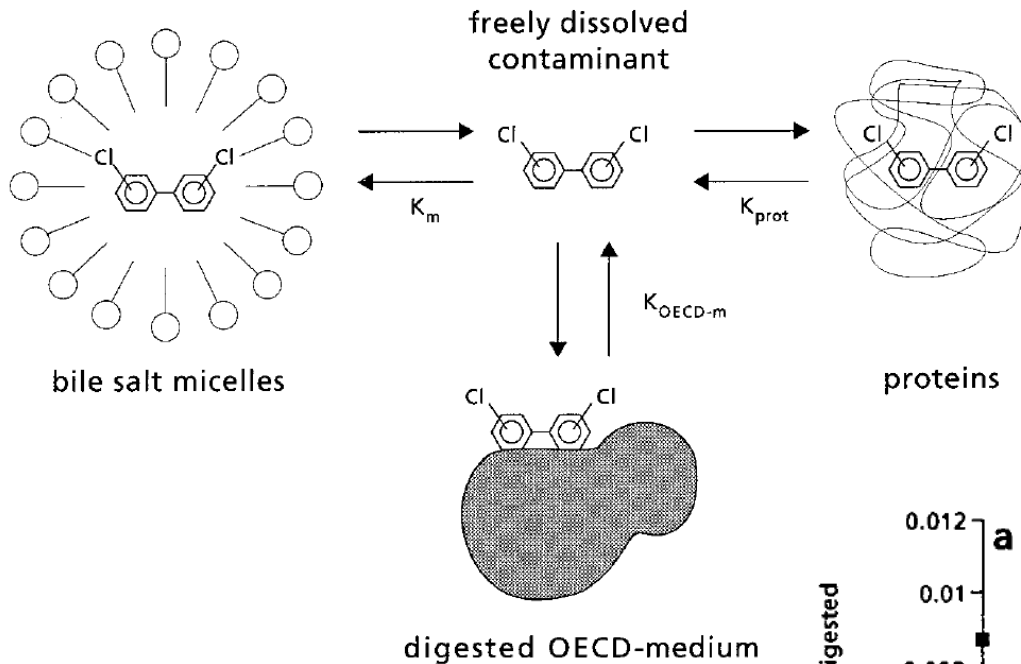


Sample  
centrifuged,  
and  
supernatant  
taken for  
analysis/colon  
medium added  
to soil pellet.

# Standard format?

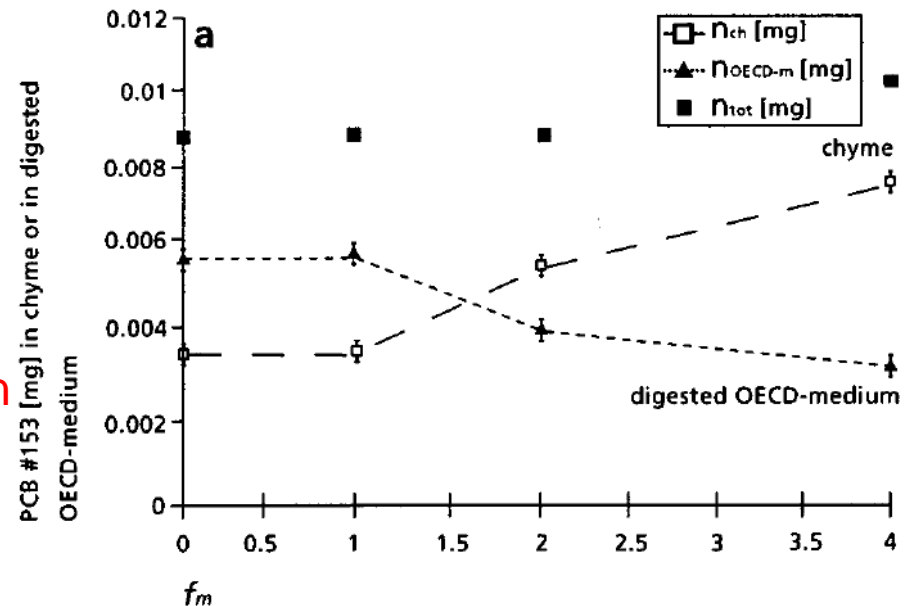
Model	Researchers	Compartments	Dietary status	Bile salts (g l <sup>-1</sup> )
FOREhST	Cave et al 2010	Saliva, stomach, SI	Fed	1.1
SHIME (dynamic)	Cave et al 2010	Stomach, SI, colon	Fed	2.5
CEPBET	Tilston et al 2011	Stomach, SI, colon	Fed	1.75
PBET	Yu et al.	Saliva, stomach, SI	Un fed	0.9
PBET	Wang et al.	Stomach, SI	Un fed	2.5

# Influence of bile salts

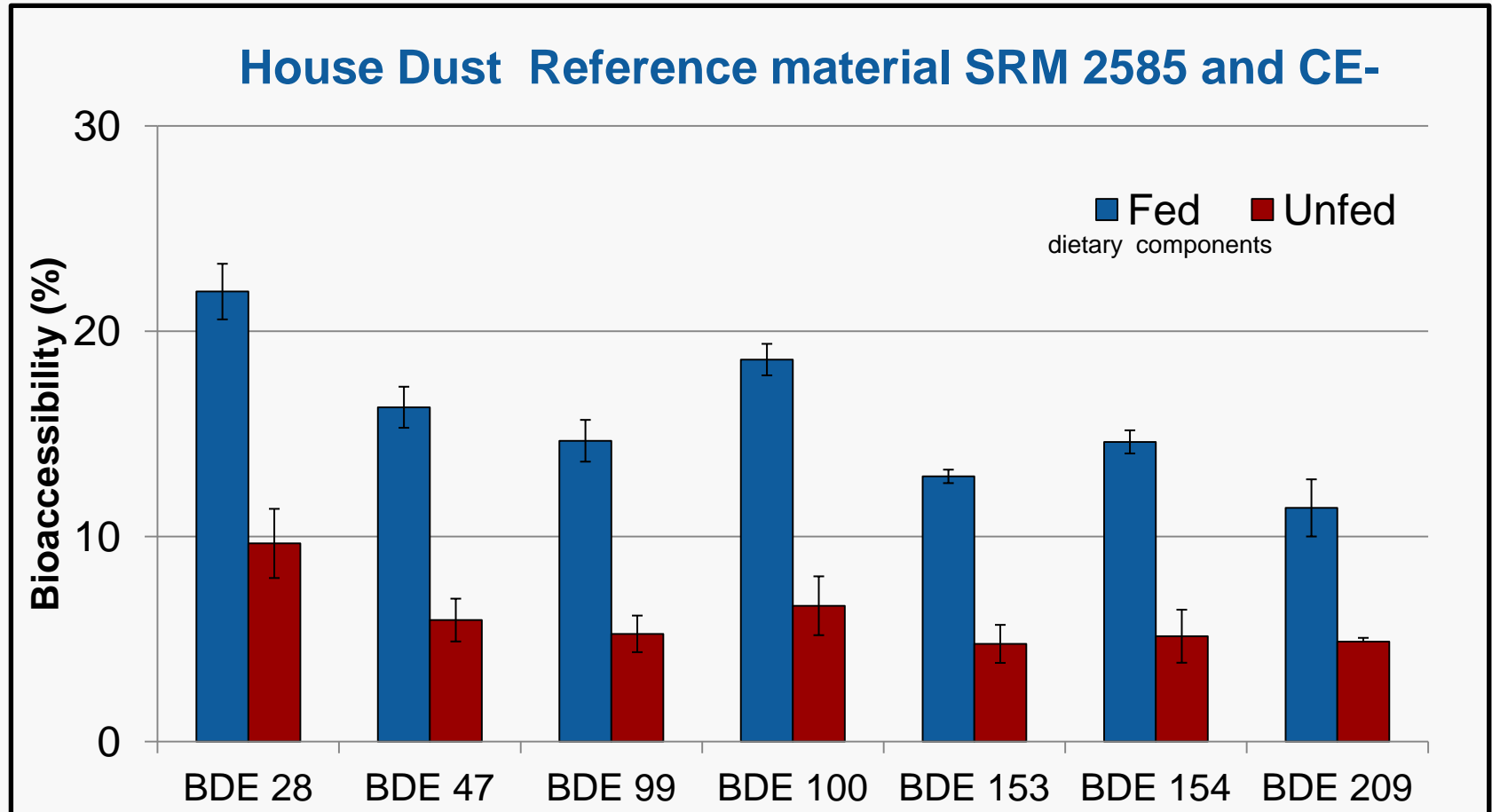


Oomen, et al 2000. *ES&T* 34, 297-303.

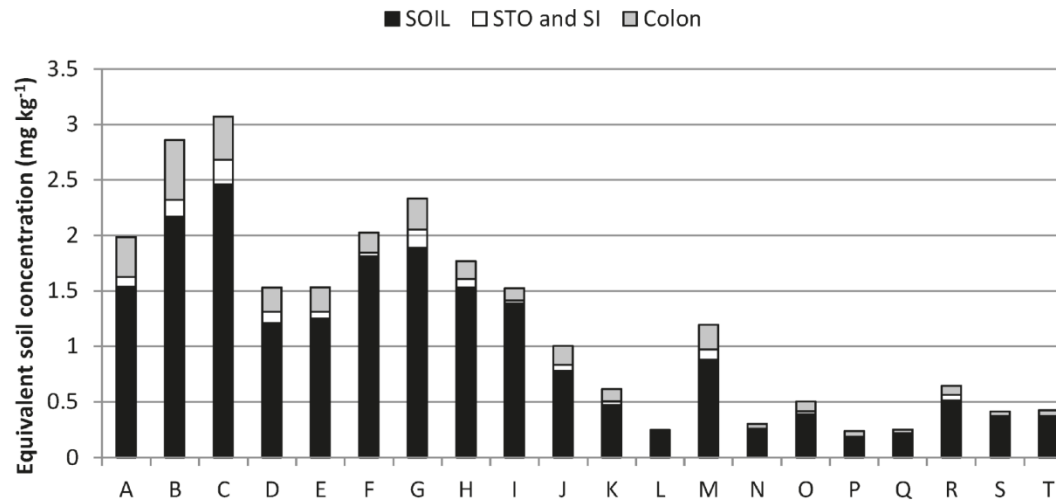
Liquid to solid ratio and other Component e.g. proteins also have an impact.



# Fed state required

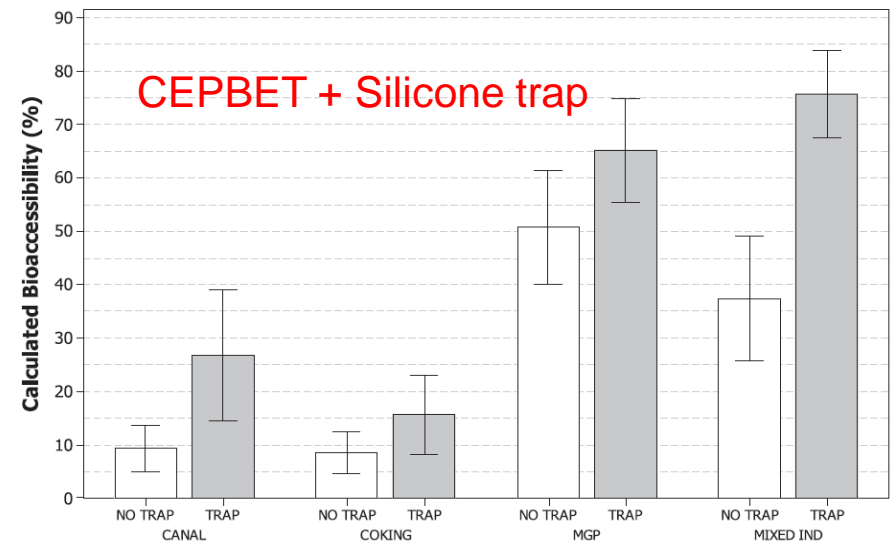
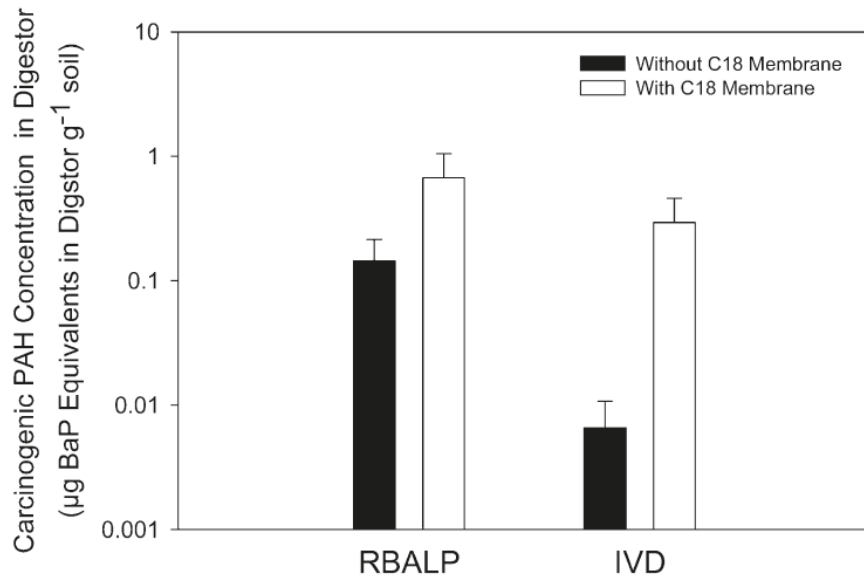


# Low bioaccessibility at gas works



**Figure 3.** Concentration of benzo(a)pyrene in residual soil, stomach, and small intestine and colon compartments after CE- PBET from 20 soils across an industrial site.

# Do we need 'sinks'

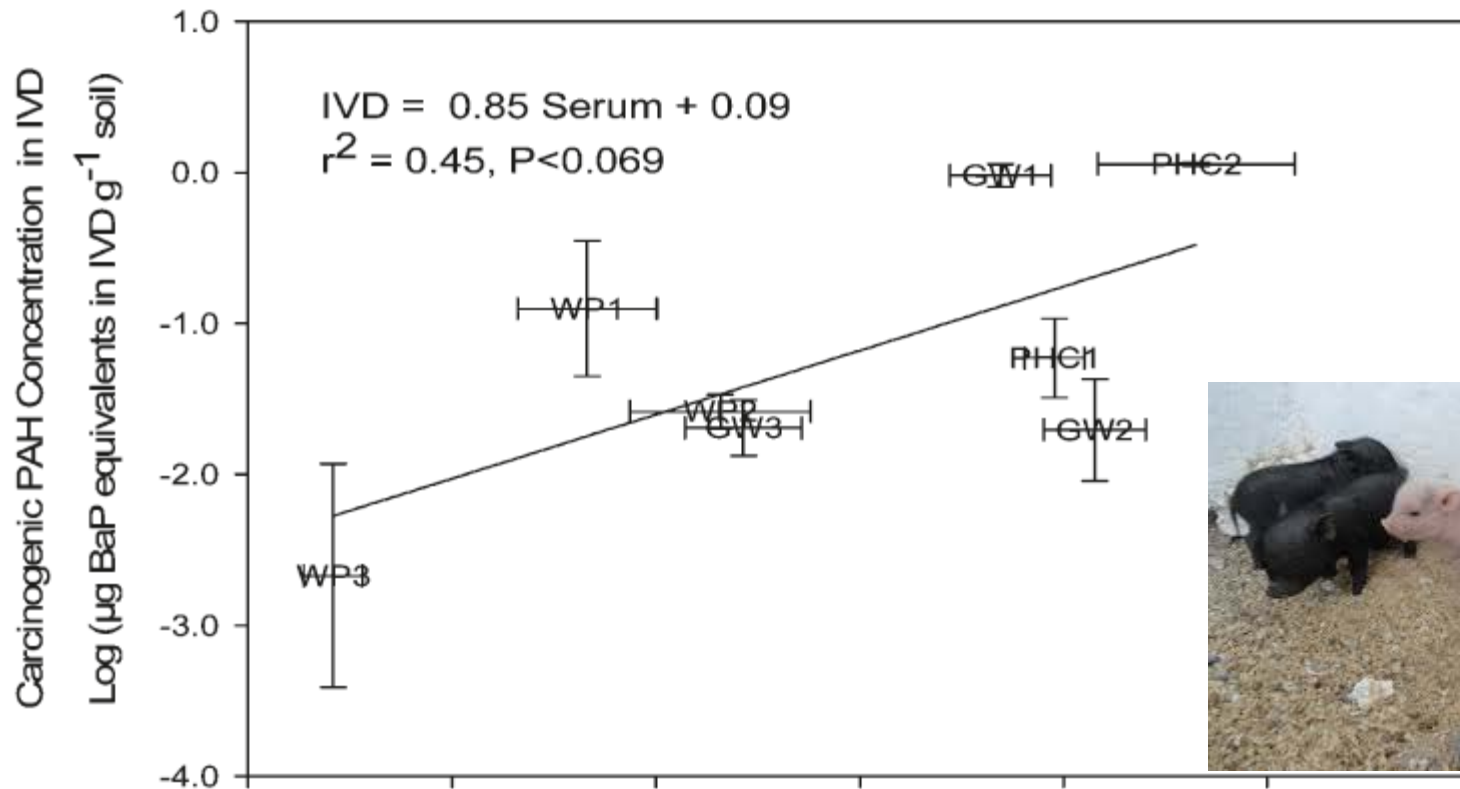


James et al (2011) *EST* 45:4586-4593

Collins et al (2013) *Env. Poll.* 181:128-132

Bile salts and food previously covered

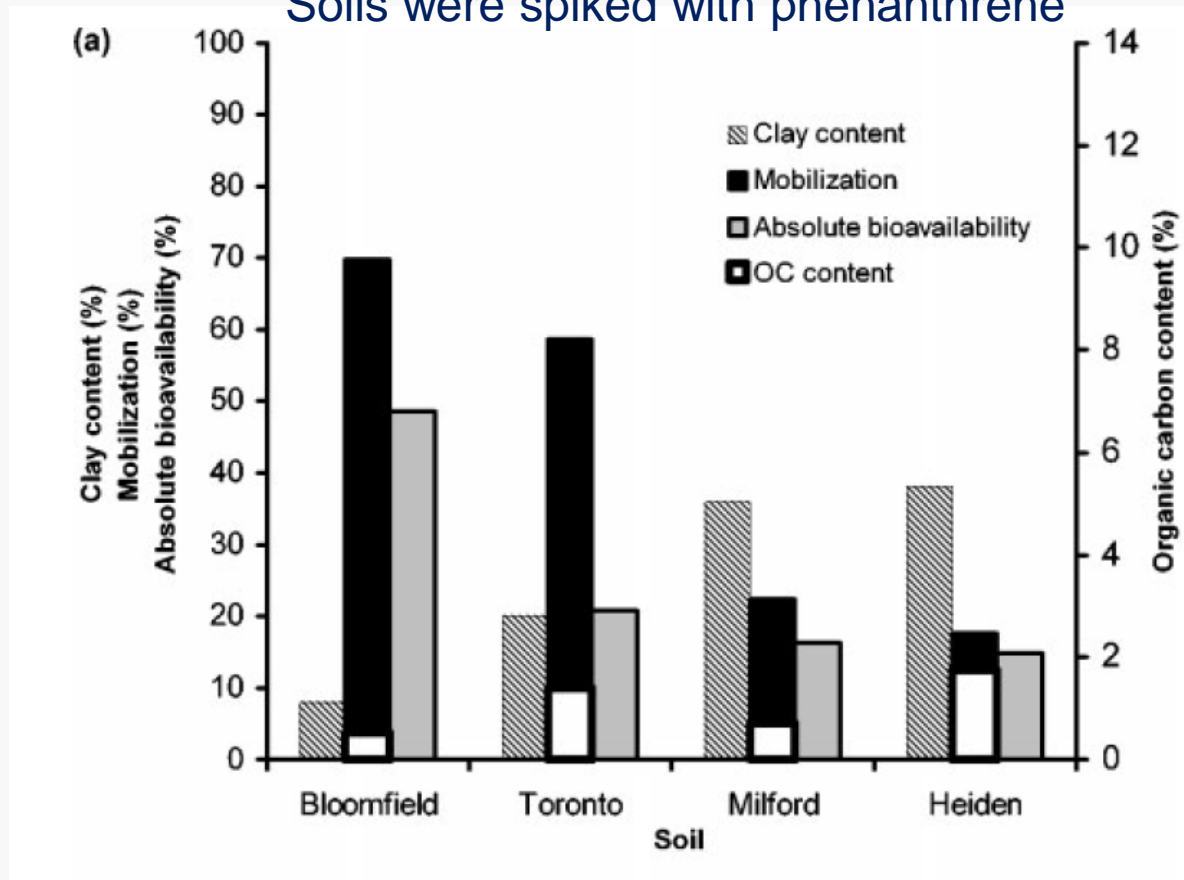
# In vivo



Carcinogenic PAH Concentration in Juvenile Swine Serum  
 Log (µg BaP equivalents in Serum g<sup>-1</sup> soil)

# In vivo

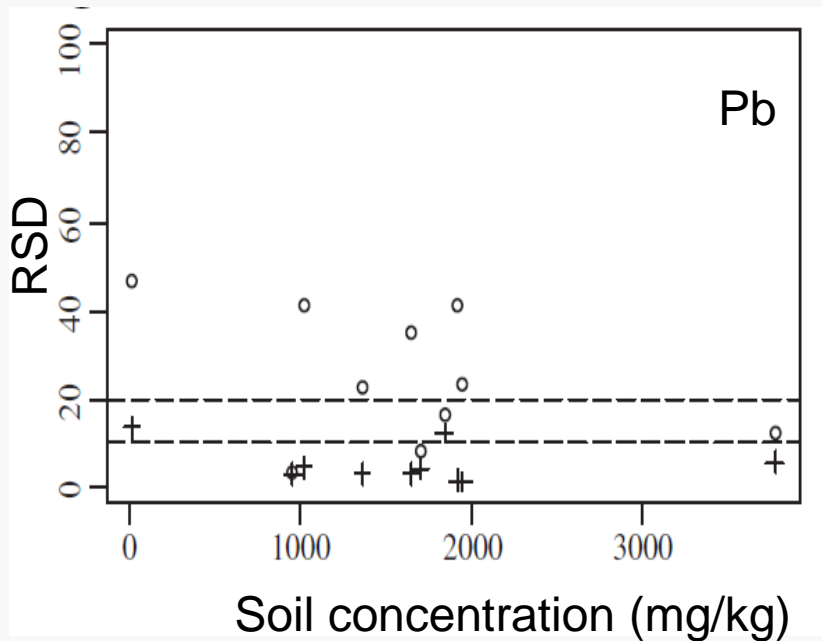
Soils were spiked with phenanthrene



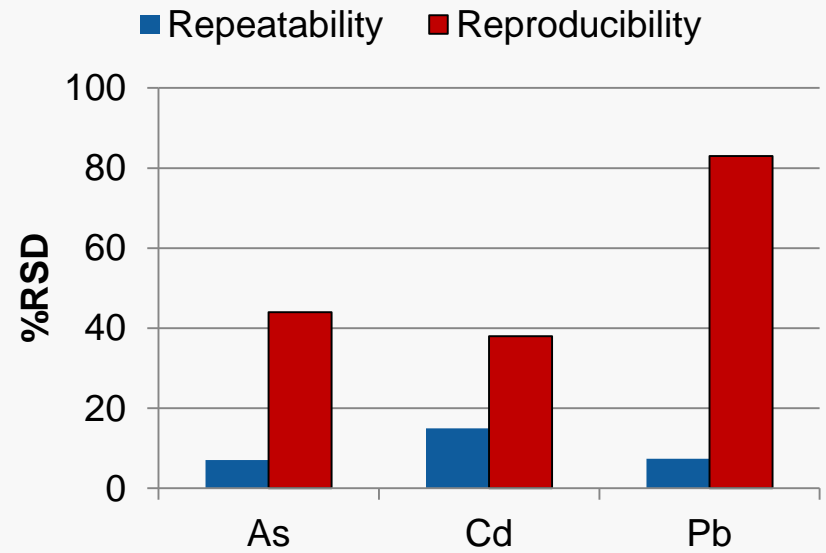
*Pu et al. 2004. Toxicological Sciences 79, 10-17.*



# Variability recorded



Wragg et al. (2011) *Sci. Total Env.* 409, 4016-4030

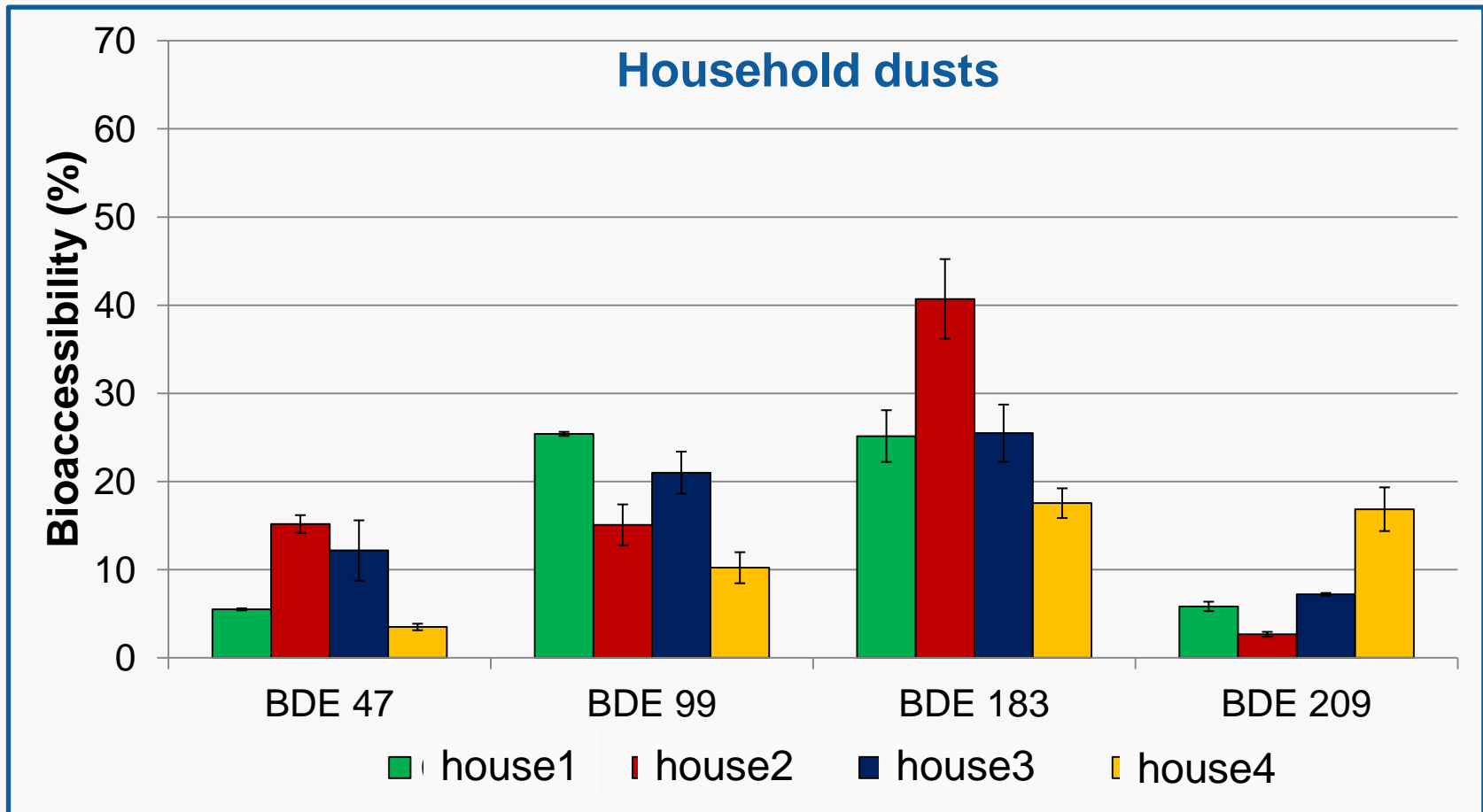


	As	Cd	Pb
NIST	626	22	5532
SGV (UK)	32	10	450

Koch et al. (2013) *J. Env. Sci. Health* 48, 641-655

# What controls bioaccessibility

# Influence of matrix - source

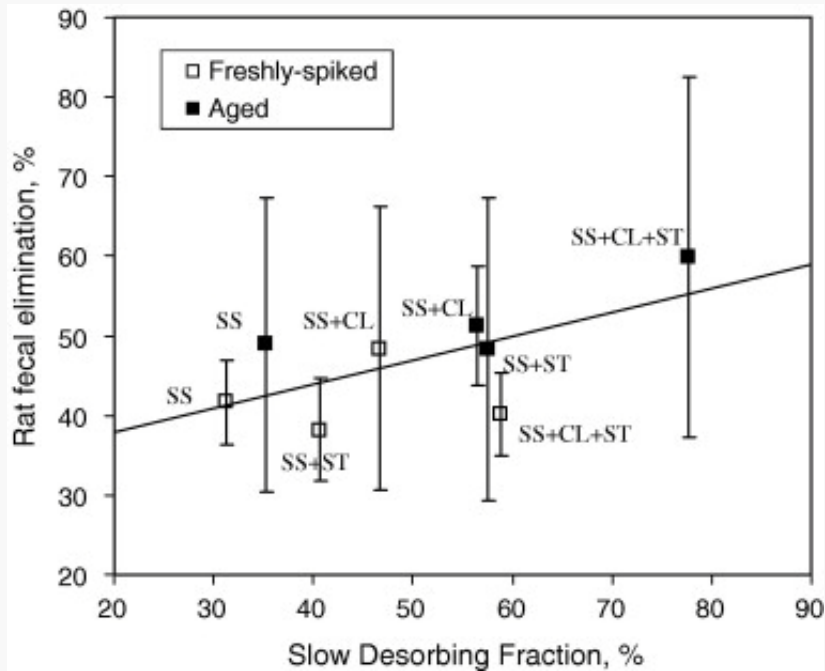


# Influence of matrix - carbon

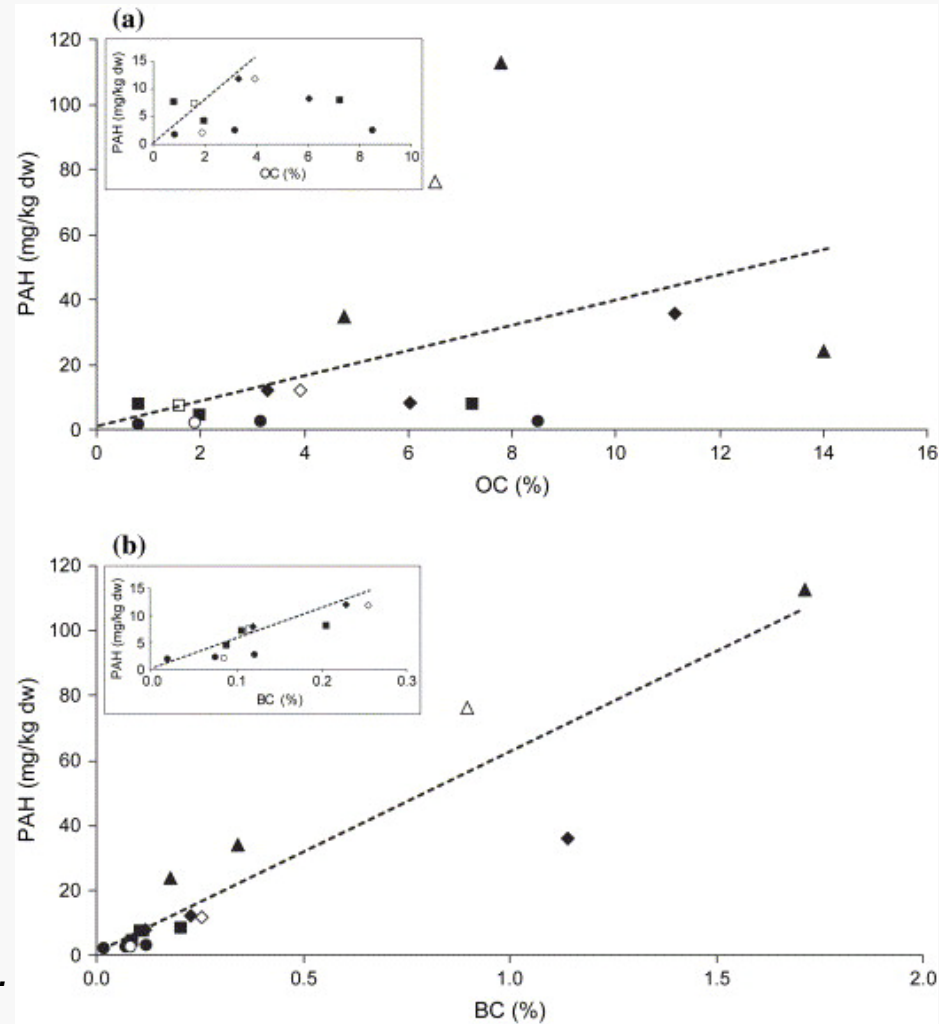
SS = standard sediment

CL = clay

ST = soot

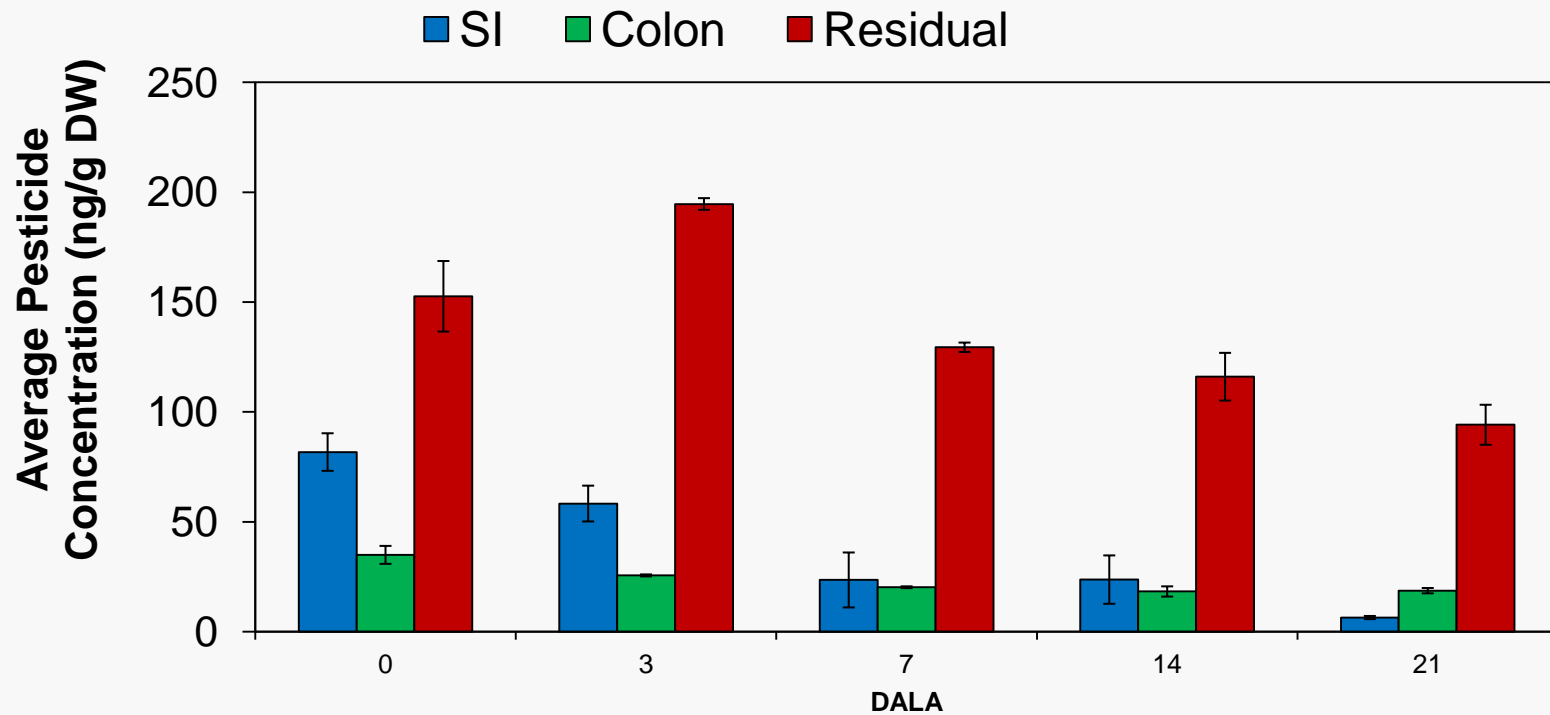


Chai et al. (2008). *Chemosphere* 72, 432-441.

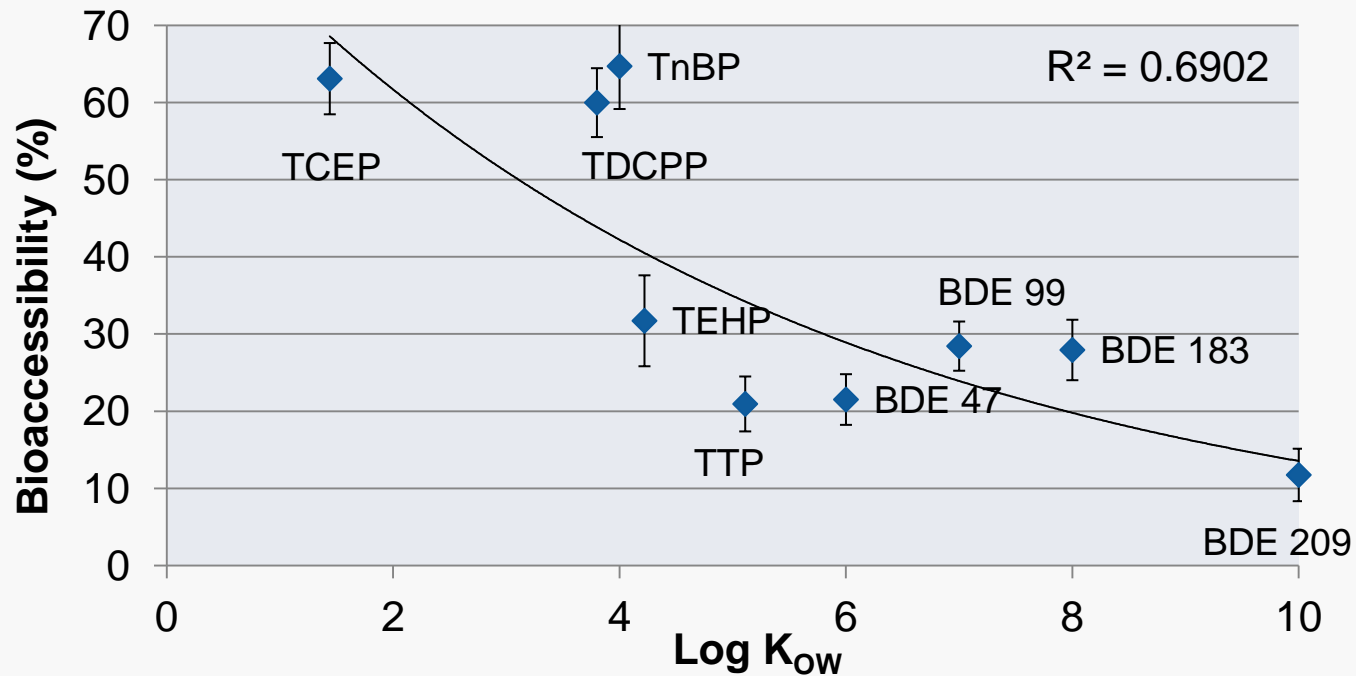


Oen et al 2006. *Env. Poll.* 141, 370-380

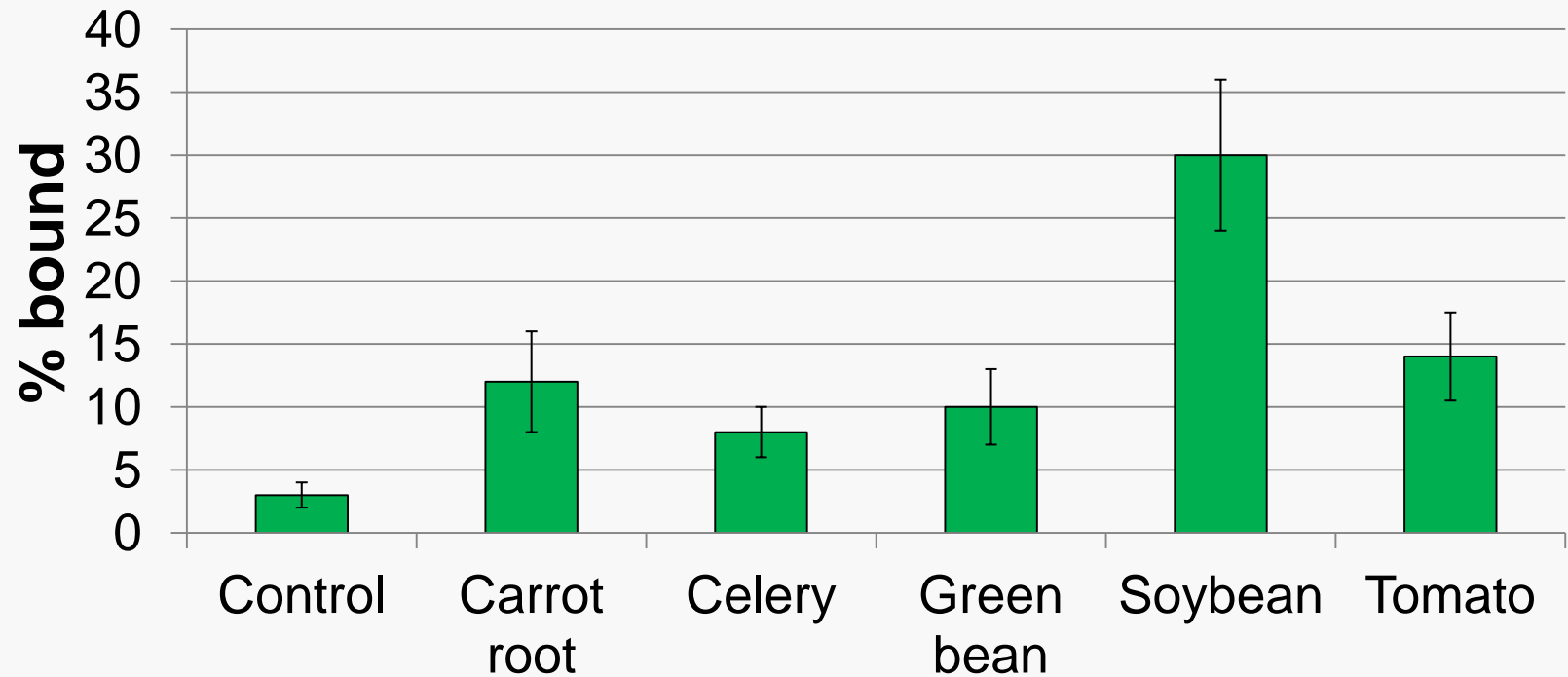
# Aging



# Influence of chemical - Kow



# Influence of matrix – food type



# Conclusions

Requirements of bioaccessibility test	Status
It should be physiologically based, mimicking the human GI physico-chemical environment in the stomach and small intestine (colon).	<b>Yes - because test systems represent known components of human digestive system</b>
It should represent a conservative case.	<b>Partial yes – not known for sure, but with addition of food, high levels of bile salts and sinks researchers are striving for this.</b>
There should be one set of conditions for all potentially harmful elements (PHE) being studied.	<b>Yes – no one is suggesting different systems for different pollutants.</b>
It must be demonstrated that the test is a good analogue of in vivo conditions.	<b>Partial yes – trends are the same between tests, but agreement could be better.</b>
The test must be able to produce repeatable and reproducible results within and between testing laboratories.	<b>Partial yes – not really known for organics but experience with PTEs would suggest repeatability is good, but reproducibility needs to improve especially at relevant concentrations.</b>



# Future needs

- We have made significant progress supported by knowledge from measurements for toxic elements
- Inter-laboratory comparisons required
  - Isolate reproducibility and repeatability
  - Appropriate soils and standards
  - High quality SOPs – video
  - Independent lab analysis
- In-vivo experiments
- End points – parent compounds/metabolites