AgroVet Strickhof

Transfer of aflatoxin, lead and cadmium from larvae reared on contaminated substrate to laying hens

M. Heuel, M. Kreuzer, I. D. M. Gangnat, E. Frossard, C. Zurbrügg J. Egger, B. Dortmans, M. Gold, A. Mathys, J. Jaster-Keller, S. Weigel, C. Sandrock, M. Terranova

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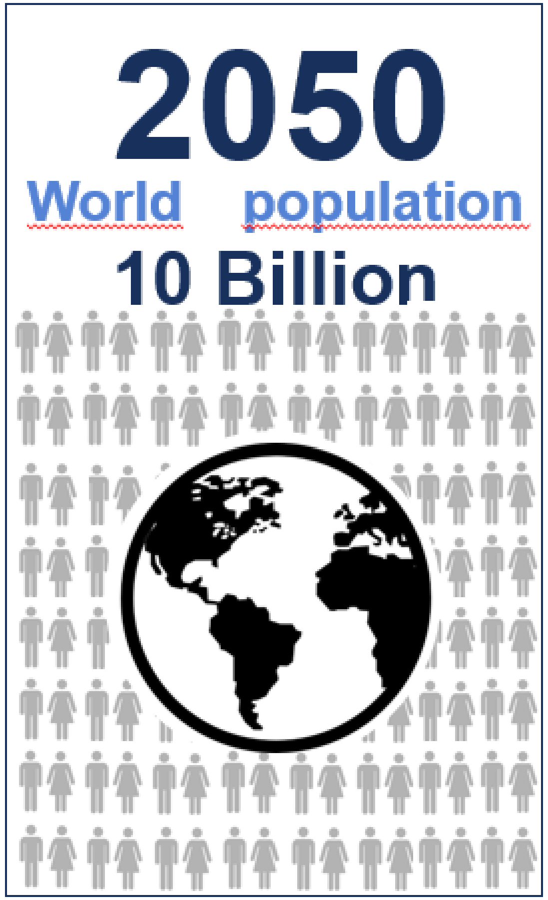
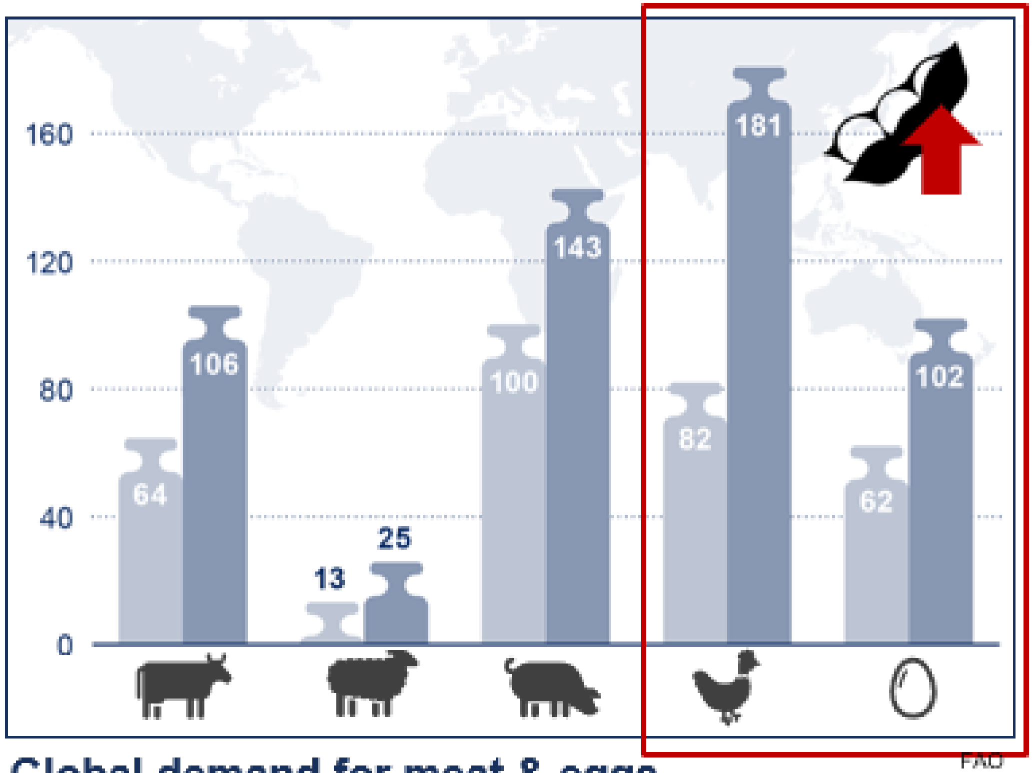
Heuel et al. 2023 – Feed Sci. and Tech. 115733

Background



→ High demand for protein-rich feeds such as soybeans



Global demand for meat & eggs
2005 vs. 2050 in Mio.tons

Environmental degradation

Deforestation

Competition

Direct use as food
Alternative use of land

Background

Alternative protein source needed

→ Black Soldier Fly Larvae (*Hermetia illucens*)

→ rich in essential amino acids & energy

→ local production possible

→ can convert rearing substrate into high-quality protein

→ applicability in poultry feeding already proved (Heuel et al. 2021, 2022)

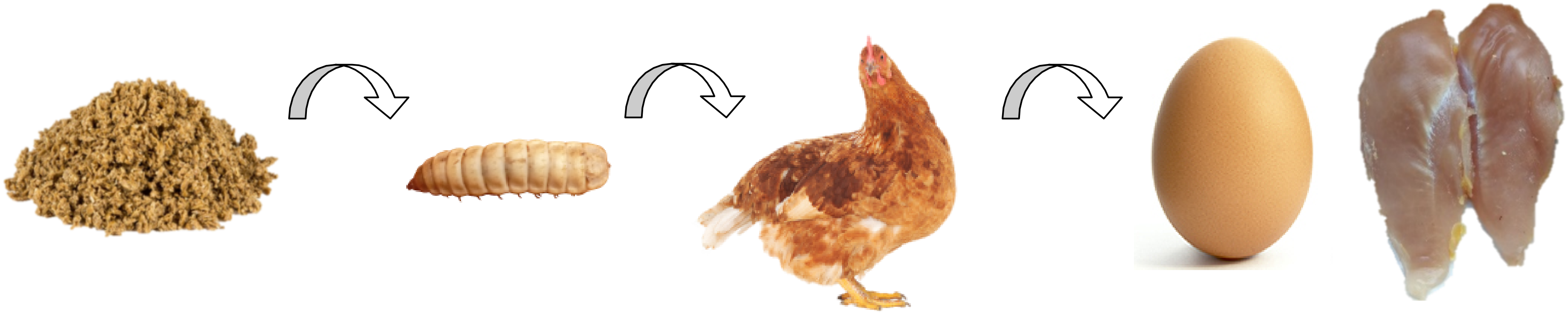
Background

- Use of low-grade rearing substrates can improve the sustainability of insect-based feed production
- BUT also poses food safety risks → mycotoxins and heavy metals

→ they might pass through the entire production chain and lead to contaminated foods

Aim

Study the transfer of the contaminants Cadmium, Lead and Aflatoxin from the rearing substrates to black soldier fly larvae (BSFL) to eggs and poultry meat



Material & Methods

Larval rearing material

- Meat containing food waste
- Not EU-approved
- Produced in Indonesia

meal C_{Ind}

+ Cd, Pb

1.9 mg Cd/kg DM
18.8 mg Pb/kg DM

meal HM

+ AFB1

1.5 mg AFB1/kg DM

meal AF

vs.

meal C_{CH}

- Food side streams
- EU-approved
- Produced in Switzerland

Material & Methods - Diets

Experimental diets

20% DM partially defatted larval meal	+	46% Wheat 14% Corn 4% Wheat bran 3% Corn gluten	+	2.7% $CaCO_3$ 7% Limestone grit 1% Dicalcium phosphate + more minerals

C_{CH}: 20% larval meal reared on approved substrate

C_{IND}: 20% larval meal reared on meat containing food waste substrate (B)

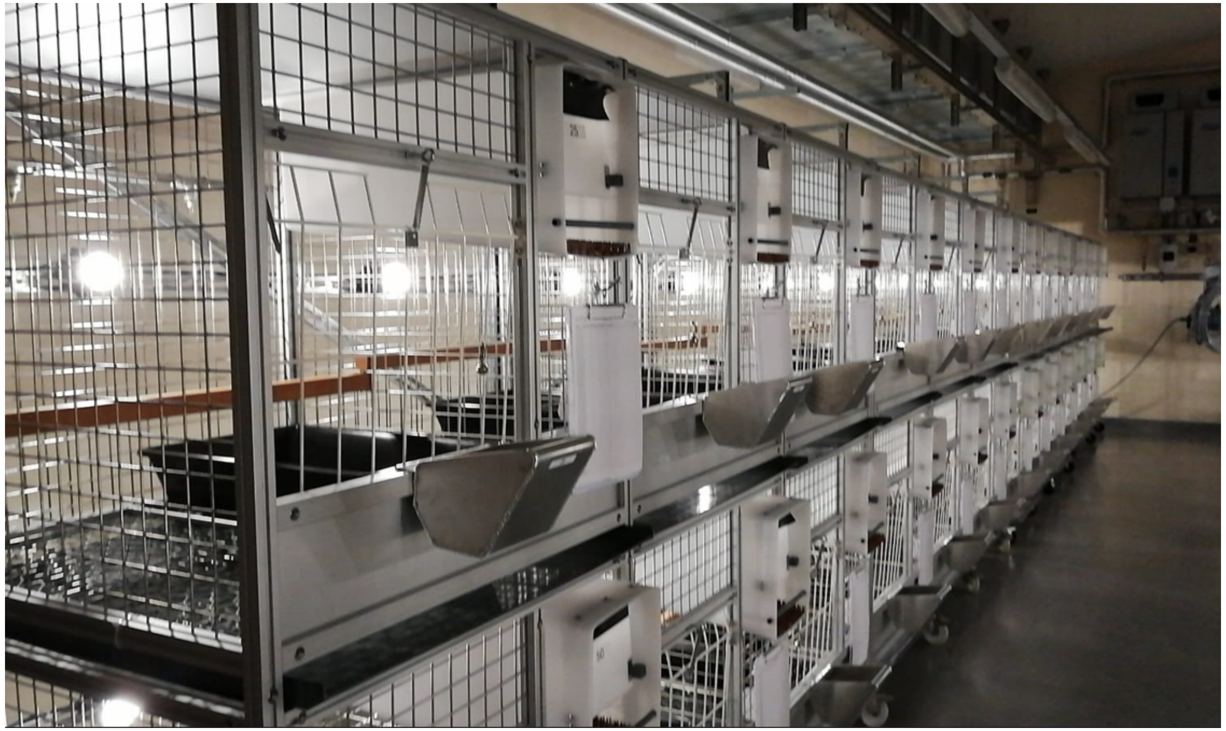
HM: 20% larval meal reared on substrate B spiked with cadmium and lead

AF: 20% larval meal reared on substrate B spiked with aflatoxin B1

Material & Methods

Animals and housing

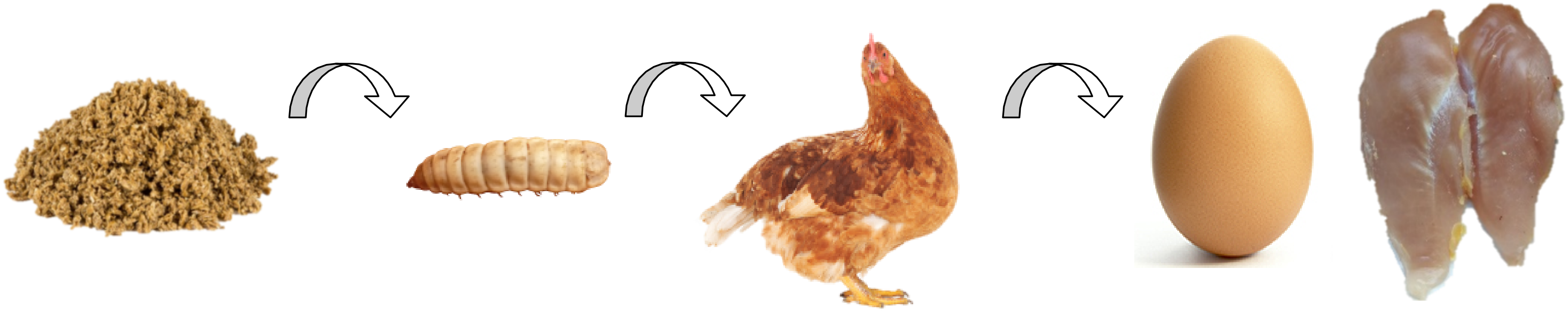
- 36 late-laying hens (Lohmann-LSL Classic)
- 92 weeks old
- Initial body weight on average 1.67 ± 0.15 kg
- Housed individually in cages
- 16 h artificial light and 8 h dark



Feeding

- 9 hens per experimental group
- Feed and water *ad libitum*

Material & Methods



Measurements

- Laying performance
- Egg quality

- Contaminants concentration in

Larvae	Liver
Feed	Kidneys
Breast meat	Eggs

Results – Diet composition

Composition of the larval meals and the experimental diets per kg DM.

	Defatted larval meal				Experimental Diets			
	C_{CH}	C_{IND}	HM	AF	C_{CH}	C_{IND}	HM	AF
Nitrogen (g)	79.9	63.1	62.0	97.0	34.5	30.4	31.9	31.0
Ether extract (g)	299	199	138	273	75.5	49.5	42.9	63.8
Cadmium (mg)	0.22	0.24	**7.08**	1.86	0.18	0.19	**1.68**	0.61
Lead (mg)	0.23	0.75	**15.5**	0.48	0.07	0.16	**3.20**	0.18
Aflatoxin B1(µg)	n.a.	n.a.	n.a.	**4.03**	n.d.	n.d.	n.d.	**1.22**

→ permitted levels in EU: 2 mg Cadmium; 10 mg Lead; 20 µg AFB1

Results – Intake and Performance

Performance of laying hens fed the experimental diets

	C_{CH}	C_{IND}	HM	AF	*P-value*
Feed intake (g/day)	108	105	101	112	0.203
Cadmium (mg/day)	0.019^{c}	0.020^{c}	**0.170^{a}**	0.068^{b}	<0.001
Lead (mg/day)	0.008^{b}	0.017^{b}	**0.324^{a}**	0.020^{b}	<0.001
Aflatoxin B1 (µg/day)	n.d.	n.d.	n.d.	**0.136**	-
Laying performance	84.3	82.4	80.5	85.1	0.886
Egg weight	62.5	63.1	63.6	65.5	0.294

n.d., not detectable

→egg quality and egg composition were not affected

Results – Lead concentration

Lead concentrations per tissue kg DM.

	C_{CH}	C_{IND}	HM	*P-value*
Liver (mg)	n.d.	0.02	n.d.	0.180
Kidneys (mg)	0.02[b]	0.07[b]	**0.49[a]**	<0.001
Breast meat (mg)		Not detectable		
Eggs (mg)		Not detectable		

n.d., not detectable

→ no transfer to breast meat and eggs

Results – Cadmium concentration

Cadmium concentrations per tissue kg DM.

	C_{CH}	C_{IND}	HM	*P-value*
Liver (mg)	0.76[b]	0.92[b]	**1.86**[a]	<0.001
Kidneys (mg)	7.13[b]	7.69[b]	**12.29**[a] *	0.004
Breast meat (mg)	0.006[b]	0.006[b]	**0.013**[a]	<0.001
Eggs (mg)	n.d.	n.d.	n.d.	-

n.d., not detectable
*exceeded permitted levels in EU

→ no transfer to eggs

Results - Fate of aflatoxin B1 in the experiment

Feed-food chain

Food waste → Spiked food waste → BSFL protein meal → Laying hen feed → Poultry products

Food waste	Spiked food waste	BSFL protein meal	Laying hen feed	Poultry products
0.82 µg AFB1/kg DM	842 µg AFB1/kg DM	4.03 µg AFB1/kg DM	1.22 µg AFB1/kg DM	Not analysed

→ Larval growth depression with a high addition of AFB1

EU treshold 20 µg/kg (12% moisture)

→ sign. lower contamination of feed + short feeding duration

Summary

- The transfer of heavy metals from larvae to egg and meat was low

- Cadmium in kidneys exceeded maximum EU levels

- AFB1 concentrations in larvae was low and below EU thresholds

→ However, accumulation of harmful metabolites cannot be excluded

- Hen performance and egg quality were not affected → food waste could be suitable rearing substrate, but long-term study in hens and studies in broilers needed

Thank you for your attention

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