

A Systematic Literature Review on the Effects of Mycotoxin Exposure on Insects, and on Mycotoxin Accumulation and Biotransformation

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Supplementary Table S3: Concentrations of parent compounds and metabolites in initial substrate, larvae, and residual material with mass balance provided of *Hermetia illucens*, *Tenebrio molitor*, and *Alphitobius diaperinus*

Hermetia illucens											
Parent compound	Type of contamination	Initial Dose (µg/kg)	Initial Conc. in Feed (µg/kg)	Conc. in Larvae (µg/kg)	Conc. in Residue(s) (µg/kg)	Metabolite (s)	Initial Conc. in Feed (µg/kg)	Conc. in Larvae (µg/kg)	Conc. in Residue (µg/kg)	Total Calculated Mass Balance %	Reference

AFB ₁	S	13	0.231	<LOD	0.010	AFM ₁		<LOD		4 ¹	Bosch et al. (2017)
	S	23	0.419	<LOD	0.032	AFM ₁		<LOD		8 ¹	
	S	49	0.875	<LOD	0.047	AFM ₁		<LOD		5 ¹	
	S	84	1.5	<LOD	0.110	AFM ₁		<LOD		7 ¹	
	S	204	3.7	<LOD	0.275	AFM ₁		<LOD		7 ¹	
	S	415	7.5	<LOD	1.3	AFM ₁		<LOD		17 ¹	
AFB ₁	S	13	13.3	<LOD	10.9	AFB ₂	2.6	<LOD	<LOQ	48 ²	Purschke et al. (2017)
						AFG ₂	7	<LOD	<LOQ		
DON	S	698	697.7	<LOD	1,135.7					163 ²	
OTA	S	39	39.4	<LOD	<LOQ					0 ²	
ZEN	S	130	130.7	<LOD	103.7					79 ²	
AFB ₁	S	20 (ww)	8 (ww)	<LOQ	5.5 + <LOQ(dw)	AFM ₁		<LOQ	<LOQ	11 ¹	Camenzuli et al. (2018)
						AFL		<LOQ	<LOQ		
						AFP ₁		<LOQ	<LOQ		
						AFQ ₁		<LOQ	<LOQ		
	S	200 (ww)	70 (ww)	<LOQ	62 + 1.8 (dw)	AFM ₁		<LOQ	<LOQ	18 ¹	
						AFL		<LOQ	<LOQ		
						AFP ₁		<LOQ	<LOQ		
						AFQ ₁		<LOQ	<LOQ		

AFB ₁ (Mix)	S	500 (ww)	390 (ww)	<LOQ	303.3 + 5.3 (dw)	AFM ₁		<LOQ	<LOQ	16 ¹
						AFL		<LOQ	<LOQ	
						AFP ₁		<LOQ	<LOQ	
						AFQ ₁		<LOQ	<LOQ	
	S	20 (ww)	18 (ww)	<LOQ	13.7 + <LOQ(dw)	AFM ₁		<LOQ	<LOQ	16 ¹
						AFL		<LOQ	<LOQ	
						AFP ₁		<LOQ	<LOQ	
						AFQ ₁		<LOQ	<LOQ	
		200 (ww)	180 (ww)	<LOQ	156.7 + 1.8 (dw)	AFM ₁		<LOQ	<LOQ	17 ¹
						AFL		<LOQ	<LOQ	
						AFP ₁		<LOQ	<LOQ	
						AFQ ₁		<LOQ	<LOQ	
	S	500 (ww)	430 (ww)	<LOQ	353.3 + 4.6 (dw)	AFM ₁		<LOQ	<LOQ	16 ¹
						AFL		<LOQ	67 + <LOQ (dw)	
						AFP ₁		<LOQ	<LOQ	
						AFQ ₁		<LOQ	<LOQ	

DON	S	5,000 (ww)	3,900 (ww)	<LOQ	7,700 + 300 (dw)					39 ¹	
	S	50,000 (ww)	38,000 (ww)	129.3 (dw)	86,300 + 2,500 (dw)					45 ¹	
	S	125,000 (ww)	112,000 (ww)	256.7 (dw)	316,700 +5,500 (dw)					55 ¹	
DON (Mix)	S	5,000 (ww)	4,100 (ww)	<LOQ	15,700 + 200 (dw)					80 ¹	
	S	50,000 (ww)	41,000 (ww)	109.5 (dw)	150,000 + 1,800 (dw)					74 ¹	
	S	125,000 (ww)	100,000 (ww)	176.7 (dw)	296,700 + 4,200(dw)					55 ¹	
OTA	S	100 (ww)	170 (ww)	<LOQ	400 + 5.1 (dw)					53 ¹	
	S	1,000 (ww)	1,300 (ww)	2.2 (dw)	3,500 +26.3 (dw)					57 ¹	
	S	2,500 (ww)	1,700 (ww)	2.6 (dw)	5,100 + 45.0 (dw)					56 ¹	

OTA (Mix)	S	100 (ww)	80 (ww)	<LOQ	200 + <LOQ(dw)					41 ¹	
	S	1,000 (ww)	800 (ww)	1.8 (dw)	2,500 + 27.3 (dw)					62 ¹	
	S	2,500 (ww)	2,000 (ww)	3.9 (dw)	5,000 + 69.0 (dw)					46 ¹	
ZEN	S	500 (ww)	280 (ww)	<LOQ	700 + <LOQ (dw)	α -ZEL		<LOQ	<LOQ (dw)	104 ¹	
	S					β -ZEL		<LOQ	180 + <LOQ (dw)		
	S	5,000 (ww)	2,500 (ww)	<LOQ	6,600 +183.3 (dw)	α -ZEL	5 (dw)	7,200 + 140 (dw)	128 ¹		
	S					β -ZEL		<LOQ		2,300 + 42 (dw)	
	S	12,500 (ww)	13,000 (ww)	27.5 (dw)	35,300 + 26.3 (dw)	α -ZEL	25 (dw)	37,300 + 600 (dw)	133 ¹		

	S					β -ZEL		7 (dw)	11,200 + 180 (dw)		
ZEN (Mix)	S	500 (ww)	400 (ww)	<LOQ	990 + <LOQ (dw)	α -ZEL		<LOQ	740 + 22 (dw)	100 ¹	
						β -ZEL		<LOQ	200 + <LOQ (dw)		
	S	5,000 (ww)	3,800 (ww)	<LOQ	10,200 + 78.7 (dw)	α -ZEL		11 (dw)	12,700 + 210 (dw)	143 ¹	
						β -ZEL		<LOQ	3,600 + 71 (dw)		
	S	12,500 (ww)	9,400 (ww)	<LOQ	22,700 + 226.7 (dw)	α -ZEL		29 (dw)	28,300 + 630 (dw)	118 ¹	
						β -ZEL		6.7 (dw)	8,600 + 130 (dw)		

DON	NC, CDR		779	<LOD	1,473	3-AcDON	<LOD	<LOD	<LOD	± 81 ¹	Leni et al. (2019)
FB ₁	NC, CDR		573	<LOD	951					± 72 ¹	
FB ₂	NC, CDR		441	<LOD	344					± 5 ¹	
ZEN	NC, CDR		<LOD	<LOD	334						
Tenebrio Molitor											
Parent compound	Type of contamination	Initial Dose (µg/kg)	Initial Conc. in Feed (µg/kg)	Conc. in Larvae (µg/kg)	Conc. in Residue (µg/kg)	Metabolite (s)	Initial Conc. in Feed (µg/kg)	Conc. in Larvae (µg/kg)	Conc. in Residue (µg/kg)	Total Calculated Mass Balance %	Reference
AFB ₁	S	13	0.115	<LOD	0.005	AFM ₁		<LOD		4 ¹	Bosch et al. (2017)
	S	23	0.209	<LOD	0.013	AFM ₁		0.0017		6 ¹	
	S	49	0.437	0.001	0.035	AFM ₁		<LOD		8 ¹	
	S	84	0.756	0.001	0.083	AFM ₁		0.0009		11 ¹	
	S	204	1.8	0.002	0.139	AFM ₁		0.0009		8 ¹	

	S	415	3.7	0.002	0.352	AFM ₁		0.0011		9 ¹	
DON	NC		200	136	131	3-AcDON	<LOD	66	286	234 ²	Sanabria et al. (2019)
						15-AcDON	<LOD	<LOD	<LOD		
						Nivalenol ³	<LOD	<LOD	50		
	NC		2,000	127	324	3-AcDON	63	66	323	31 ²	
						15-AcDON	<LOD	<LOD	<LOD		
						Nivalenol ³	<LOD	<LOD	<LOD		
	NC		10,000	122	230	3-AcDON	52	66	326	6 ²	
						15-AcDON	<LOD	<LOD	<LOD		
						Nivalenol ³	<LOD	<LOD	51		
	NC		12,000	131	742	3-AcDON	205	65	280	8 ²	
						15-AcDON	<LOD	<LOD	<LOD		
						Nivalenol ³	<LOD	<LOD	<LOD		
DON (mix)	NC	2854	99.9	<LOD	51.6					52 ²	Niermans et al. (2019)
	NC	602.3	21.1	<LOD	4.8	α -ZEL	<LOD	<LOD	1.8	48 ²	

ZEN (mix)						β-ZEL	0.2	<LOD	3.6		
DON (mix)	NC	4588	160.6	<LOD	73.9					46 ²	
ZEN (mix)	NC	919.3	32.2	<LOD	6.0	α -ZEL	<LOD	<LOD	3.8	49 ²	
						β-ZEL	0.4	<LOD	6.2		
DON (mix)	AC	939	32.9	<LOD	18.5					56 ²	
ZEN (mix)	AC	427	14.9	<LOD	6.0	α -ZEL	<LOD	<LOD	1.2	75 ²	
						β-ZEL	0.4	<LOD	4.2		
DON (mix)	AC	2101	73.5	<LOD	39.3					53 ²	
ZEN (mix)	AC	2283	79.9	<LOD	26.2	α -ZEL	<LOD	<LOD	6.8	62 ²	
						β-ZEL	1.7	<LOD	17.3		
DON (mix)	S	568	19.9	<LOD	11.5					58 ²	
ZEN (mix)	S	589	20.6	<LOD	11.6	α -ZEL	<LOD	<LOD	0.3	67 ²	
						β-ZEL	<LOD	<LOD	2.0		

DON (mix)	S	576	20.2	<LOD	11.7					58 ²	
ZEN (mix)	S	2254	78.9	<LOD	49.6	α -ZEL	<LOD	<LOD	3.8	79 ²	
						β -ZEL	0.1	<LOD	9.0		
FB ₁	S	50,000	44,000		31,000					38 ¹	Abado Becognee et al. (1997)
	S	150,000	140,000		87,000					42 ¹	
	S	450,000	398,000		276,000					39 ¹	
DON	NC	4,900		<LOD	1,140	DON-3G		<LOD	<LOD	14 ¹	van Broekhoven et al. (2017)
						15- AcDON		<LOD	<LOD		
DON	S	8,000		<LOD	4,980	DON-3G		<LOD	<LOD	41 ¹	
						15- AcDON		<LOD	<LOD		
T-2 (mix)	NC		88.8	<LOD	58.6	HT-2	11.1	<LOD	<LOD	59 ²	Piacenza et al. (2020)
						T-2 triol		<LOD	<LOD		
						T-2 tetraol		<LOD	<LOD		
T-2 (mix)	NC		262.3	<LOD	135.8	HT-2	26.0	<LOD	<LOD	47 ²	
						T-2 triol		<LOD	<LOD		

						T-2 tetraol		<LOD	<LOD		
T-2 (mix)	AC		53.9	<LOD	29.7	HT-2	51.6	<LOD	34.1	60 ²	
						T-2 triol		<LOD	<LOD		
						T-2 tetraol		<LOD	<LOD		
T-2 (mix)	AC		139.8	<LOD	51.1	HT-2	120.9	<LOD	34.1	33 ²	
						T-2 triol		<LOD	<LOD		
						T-2 tetraol		<LOD	<LOD		
Alphitobius diaperinus											
Parent compound	Type of contamination	Initial Dose (µg/kg)	Initial Conc. in Feed (µg/kg)	Conc. in Larvae (µg/kg)	Conc. in Residue(s) (µg/kg)	Metabolite (s)	Initial Conc. in Feed (µg/kg)	Conc. in Larvae (µg/kg)	Conc. in Residue (µg/kg)	Total Calculated Mass Balance %	Reference
AFB ₁	S	20 (ww)	8 (ww)	<LOD	5.7 + <LOQ (dw)	AFM ₁		<LOQ	<LOQ	56 ¹	Camenzuli et al. (2018)
						AFL		<LOQ	<LOQ		
						AFP ₁		<LOQ	<LOQ		
						AFQ ₁		<LOQ	<LOQ		
	S	200 (ww)	70 (ww)	<LOD		AFM ₁		<LOQ	2.0 (dw)	79 ¹	

					61.7 +	AFL		<LOQ	<LOQ			
					<LOQ	AFP ₁		<LOQ	<LOQ			
					(dw)	AFQ ₁		<LOQ	<LOQ			
	S	500 (ww)	390 (ww)	<LOD	326.7 +	AFM ₁		<LOQ	11 (dw)	69 ¹		
					<LOQ	AFL		<LOQ	1.5 (dw)			
					(dw)	AFP ₁		<LOQ	<LOQ			
					AFQ ₁		<LOQ	<LOQ				
	AFB ₁ (Mix)	S	20 (ww)	18 (ww)	<LOD	17.7 +	AFM ₁		<LOQ	<LOQ		79 ¹
						<LOQ	AFL		<LOQ	<LOQ		
						(dw)	AFP ₁		<LOQ	<LOQ		
AFQ ₁							<LOQ	<LOQ				
S		200 (ww)	180 (ww)	<LOD	153.3 +	AFM ₁		<LOQ	5.5 (dw)	71 ¹		
					<LOQ	AFL		<LOQ	<LOQ			
					(dw)	AFP ₁		<LOQ	<LOQ			
					AFQ ₁		<LOQ	<LOQ				
S		500 (ww)	430 (ww)	<LOD		AFM ₁		<LOQ	11 (dw)	80 ¹		

					413.3 + <LOQ (dw)	AFL		<LOQ	1.3 (dw)		
						AFP ₁		<LOQ	<LOQ		
						AFQ ₁		<LOQ	<LOQ		
DON	S	5,000 (ww)	3,900 (ww)	<LOD	4,300 + <LOQ (dw)					90 ¹	
	S	50,000 (ww)	38,000 (ww)	<LOD	44,700 + <LOQ (dw)					96 ¹	
	S	125,000 (ww)	112,000 (ww)	<LOD	110,000 + 263.3					80 ¹	
DON (Mix)	S	5,000 (ww)	4,100 (ww)	<LOD	4,700 + <LOQ (dw)					92 ¹	
	S	50,000 (ww)	41,000 (ww)	<LOD	47,300 + <LOQ (dw)					91 ¹	

	S	125,000 (ww)	100,000 (ww)	<LOD	116,700 + <LOQ (dw)					94 ¹	
OTA	S	100 (ww)	170 (ww)	<LOD	210 + <LOQ (dw)					97 ¹	
	S	1,000 (ww)	1,300 (ww)	<LOD	2,400 + <LOQ (dw)					111 ¹	
	S	2,500 (ww)	1,700 (ww)	<LOD	1,900 + <LOQ (dw)					115 ¹	
OTA (Mix)	S	100 (ww)	80 (ww)	<LOD	120 + <LOQ (dw)					116 ¹	
	S	1,000 (ww)	800 (ww)	<LOD	1,100 + <LOQ (dw)					111 ¹	
	S	2,500 (ww)	2,000 (ww)	<LOD	3,100 + 2.4 (dw)					126 ¹	

ZEN	S	500 (ww)	280 (ww)	<LOD	280 +	α -ZEL		<LOQ	23 (dw)	88 ¹	
	S				<LOQ (dw)	β -ZEL		<LOQ	<LOQ		
	S	5,000 (ww)	2,500 (ww)	<LOD	3,000 +	α -ZEL		<LOQ	203 (dw)	109 ¹	
	S				<LOQ (dw)	β -ZEL		<LOQ	102 (dw)		
	S	12,500 (ww)	13,000 (ww)	<LOD	13,700 +	α -ZEL		<LOQ	820 (dw)	91 ¹	
	S				<LOQ (dw)	β -ZEL		<LOQ	320 (dw)		
ZEN (Mix)	S	500 (ww)	400 (ww)	<LOD	490 +	α -ZEL		<LOQ	30 (dw)	105 ¹	
	S				<LOQ (dw)	β -ZEL		<LOQ	11 (dw)		
	S	5,000 (ww)	3,800 (ww)	<LOD	4,300 +	α -ZEL		<LOQ	350 (dw)	100 ¹	
	S				<LOQ (dw)	β -ZEL		<LOQ	140 (dw)		
	S	12,500 (ww)	9,400 (ww)	<LOD		α -ZEL		<LOQ	740 (dw)	117 ¹	

	S				12,700 + <LOQ (dw)	β-ZEL		<LOQ	270 (dw)		
DON	NC, CG		1207	726	827	3-AcDON	<LOD	<LOD	<LOD	± 43 ¹	Leni et al. (2019)
FB ₁	NC, CG		727	127	728					± 55 ¹	
FB ₂	NC, CG		294	<LOD	<LOD					± 6 ¹	
DON	NC, WM		938	416	<LOD	3-AcDON	<LOD	<LOD	<LOD	± 6 ¹	
DON	NC, CDR		779	468	587	3-AcDON	<LOD	<LOD	<LOD	± 22 ¹	
FB ₁	NC, CDR		573	<,LOD	224					± 12 ¹	
FB ₂	NC, CDR		441	<LOD	<LOD					± 2 ¹	

1

2 AC: Artificially Contaminated, CDR: Corn Distillation Residues, CG: Corn Gluten Feed, Conc.: concentration, dw: dry weight, LOD: Limit of Detection, LOQ:

3 Limit of Quantification, NC: Naturally Contaminated, S: Spiked, WM: Wheat Middlings, ww: wet weight.

4 ¹The percentage of the mass balance is as calculated by the respective authors.

5 ²Mass balance = calculated as follows: $\frac{\text{Concentration of Parent Compound and Metabolites in Residues}}{\text{Initial Concntration of Parent Compound and Metabolites in Feed}} * 100$

6 ³ Nivalenol is not a metabolite of DON, but a known co-occurring type B-trichothecene, which was not present in the initial diets, but was found back in the
7 residue material.