

Canadian Grain Commission canadienne Commission des grains des grains



Mycotoxins in Oats: What are They, Where are They, and Why They Matter

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- Federal government agency that certifies the quality, safety and weight of Canadian grain
- Grain Research Laboratory works on factors affecting grain quality and safety







What are they?

- fungal secondary metabolites
 - chemical signals
 - chemical defense
 - chemical offense





What are they?

- there is a wide variety of mycotoxins in grain
- internationally, most issues centre around:
 - aflatoxins
 - fumonisins
 - zearalenone (ZEA)
 - ochratoxin A (OTA)
 - deoxynivalenol (DON)
 - ergot alkaloids

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- CGC monitors mycotoxins in grain
 - approximately 35 mycotoxins are routinely monitored
- Canadian grain routinely meets regulations regarding DON and OTA in grain exports

Why do they matter?

- can cause food-borne and feed-borne illness
 - immunosupression, kidney toxin, feed refusal, decreased milk production, decreased blood flow, etc.



fusarium head blight in wheat is related to DON



ergot sclerotia in wheat contain ergot alkaloids



Pieter Breugel, 16th century Flemish painter Art History Museum, Vienna

Why do they matter?

Jurisdiction	Commodity	Mycotoxin	Maximum level	
international	cereal-based foods for infants and young children	deoxynivalenol	200 µg/kg	
Canada	raw cereals	ochratoxin A	5 μg/kg (proposed guideline)	
Canada	directly consumed cereal grains and cereal-derived products	ochratoxin A	3 μg/kg (proposed guideline)	
European Union	processed cereal-based foods for infants and young children	aflatoxins	0.10 µg/kg	
European Union	unprocessed cereals	ochratoxin A	5 μg/kg	
European Union	unprocessed oats	deoxynivalenol	1750 µg/kg	
European Union	oats (with husk)	T-2/HT-2	1000 μg/kg (indicative level)	

Why do they matter?

 in 2009, topic of ochratoxin A in infant food was in the news



Heinz recalls baby cereal

JILL MAHONEY

Globe and Mail Update Published Friday, Dec. 11, 2009 7:10AM EST Last updated Thursday, Aug. 23, 2012 12:17PM EDT

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Where are they?

Grain	DON +	NIV +	MON +	15-ADON +	ZEAR +	Others +
Barley	15%	15%	0	0	0	0
Corn	100%	0		22%	56%	0
Oats	100%	0		0	0	0
Rye	100%	0		0	0	0
Durum	68%	0	100%	0	0	0
Wheat	86%	0	17%	0	0	0
Soybeans	2%	0		0	0	0
Canola	0	0		0	0	0
Peas	0	0		0	0	0

Journal of Agricultural and Food Chemistry, 2013, 62:7412

Research in collaboration with POGA

- Activity 1. Occurrence of toxigenic *Fusarium* and *Penicillium* fungi and their associated mycotoxins
 - Activity 2. Investigation of the fate of *Fusarium* and *Penicillium* species and their associated mycotoxins during processing of oats
- Funding from CGC, POGA, Saskatchewan Ministry of Agriculture, and Canada-Saskatchewan Growing Forward 2 bi-lateral agreement

Oat deliveries to mills and shipments from primary elevators

- Emerson Milling, Emerson MB
- Grain Millers, Yorkton SK
- Cargill
- Viterra
- Paterson



CGC Harvest Sample Program

- voluntary program for producers to submit a harvest sample and receive a free, unofficial CGC grade and protein content measurement
- samples inspected and graded by CGC inspectors







Fungal pathogens in 2013-2014



Fungal pathogens in HSP oats 2015



Mould load in oats 2013-14



Mould load in oats 2015



% of oat samples containing mycotoxins

Storage-related	OTA 6%	citrinin 0%			
Aflatoxins	AFB ₁ 0%	AFB ₂ 0%	AFG ₁ 0%	AFG ₂ 0%	
Fusarium	DON	D3G	3-ADON	15-ADON	
graminearum	67%	24%	2%	0%	
other <i>Fusarium</i>	nivalenol	zearalenone	HT2	T2	
compounds	16%	5%	5%	4%	
other <i>Fusarium</i>	beauvericin	enniatin A	enniatin A1	enniatin B	enniatin B1
compounds	96%	11%	10%	49%	11%
Fumonisins	FB1 0%	FB2 0%			
Alternaria	alternariol	AME	altenuene	tentoxin	
compounds	85%	83%	0.4%	92%	

Mycotoxin concentrations observed in oats

	Mycotoxin	Median + (µg/kg)	% +	% + N. Europe	Maximum (µg/kg)	Maximum N. Europe
Storage- related	OTA	2.2	6%	29%	13.2	2.2
Fusarium graminearum	DON	188	67%	32-94%	4100	21608
other <i>Fusarium</i> compounds	HT2	74	5%	71-92%	256	7584
	T2	50	4%	71-84%	99	2406
other <i>Fusarium</i> compounds	beauverici n	20	96%	100%	271	220
	alternariol	30	85%	93%	5760	449
Alternaria compounds	AME	46	83%	100%	7870	177
	tentoxin	55	92%	93%	322	4

POGA 2016 12 01

DON in 2014 and 2015 harvest samples



Presence of FUSARIUM DAMAGE has increased over time

70.0 60.0 50.0 % of samples 40.0 CWRS 30.0 CWAD 20.0 10.0 0.0 2006 2008 2010 2012 2014 2016 2002 2004 2018 Harvest year

FUS DMG was reason for downgrade

Susceptibility of oats to Fusarium

 "under conditions favourable for disease, all small grain cereals will sustain damage"

Fusarium Head Blight Reaction of Cereal Varieties For Alberta Based on Varieties of Cereal and Oilseed Crops For Alberta - 2014, AARD Agdex 100/32 *T.K. Turkington*¹, and K. Xi²

Ochratoxin A in oats

- OTA was measured in deliveries to milling facilities and in composite rail car loadings over the first two years of the project
- occurrence of OTA peaks in late summer/early fall in oat deliveries and railcar loadings
- this is consistent with what has been observed for wheat exports

OTA in wheat exports varies throughout a year

POGA 2016 12 01

Date of shipment

Managing fusarium head blight and DON production

- integrated approach
 - plant healthy seed
 - crop rotation
 - stubble management
 - variety selection
 - risk maps and foliar fungicides

Preventing formation of OTA

- Grains storage is an essential part of managing OTA keep temperature and moisture content low and aerate grain regularly
- CGC Official Grain Grading Guide's specifications for dry grain are:
 - Oats (all classes): 13.5% moisture or less

Acknowledgements

- Producers submitting to the Harvest Sample Program
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Commission

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