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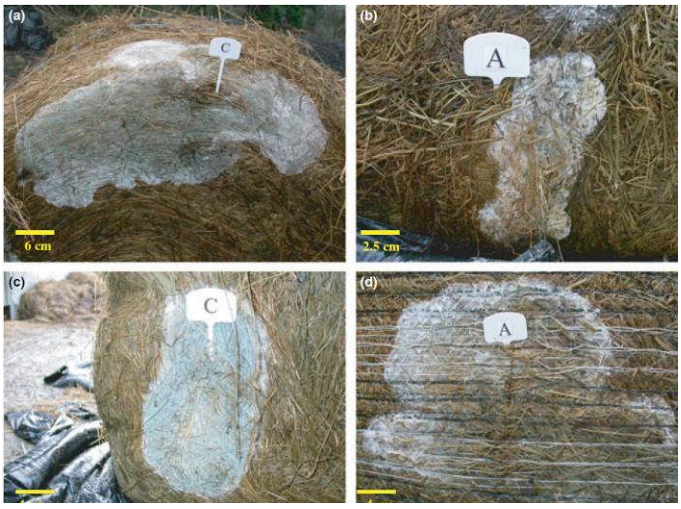
# Mycotoxins in silage




## Key external stakeholders:

Dairy/beef/ sheep farmers, veterinarians, meat/milk marketing agencies, consumers, policy makers, agri-consultants, pharmaceutical companies, agri-merchants, analytical equipment manufacturers/ distributors.

## Practical implications for stakeholders:

Mycotoxins are secondary metabolites produced by fungal moulds growing on crops or in conserved feeds such as silage, and are toxic to livestock.

- In general, the challenge to livestock and livestock products from individual mycotoxins in Irish silages appears to be low.
- Possible additive or synergistic effects of multiple mycotoxins in silage remain unknown.
- Preventing mould activity remains an essential practice during silage production and feedout since associated losses reduce the quantity and nutritive value of silage available to livestock. Visibly mouldy silage should not be offered to livestock, and should be handled with appropriate care by farmers.

## Main results:

- An analytical method was developed and validated to simultaneously detect 20 mycotoxins in silage.
- The incidence and concentrations of these mycotoxins in Irish silages were generally low. Among the EU-regulated mycotoxins, the highest value recorded in any silage was zearalenone at 4% of the EU threshold value.
- Mycotoxins produced by moulds active in crops growing in the field were more prevalent than those produced by moulds active within silage.
- Mycotoxins produced in the silo (or bale) rather than the field were more unevenly distributed within silage, and required more intensive sampling to obtain a representative sample.
- Mycotoxins recorded when silage was in the feed trough were most likely produced in the field or silo rather than in the trough.
- Conventional silage chemical composition traits did not reliably predict mycotoxin contamination.
- Crop and silo (or bale) management practices on farms were not reliable indicators of mycotoxin contamination in silages.

## Opportunity / Benefit:

The expected low challenge from individual silage mycotoxins to livestock and livestock products strengthens the marketing of Irish meat and milk products as quality assured. The low challenge also means that where farmers apply good silage production, storage and feedout practices they should not need to administer dietary agents to combat mycotoxins.

## Collaborating Institutions:

Queen's University Belfast



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**External collaborators:** Prof. Chris Elliott (Queen's University Belfast)

## 1. Project background:

Irish research has shown the widespread occurrence of visible mould and yeast growth in silages, particularly baled silages. Further studies confirmed that some of these moulds can produce a range of mycotoxins. Elevated concentrations of these mycotoxins in feedstuffs can present detrimental challenges to public health, animal health and farm profitability. Furthermore, EU mycotoxin legislation regulates the maximum concentration of a restricted number of specific mycotoxins in animal feed. However, it is not easy to predict their occurrence in silage, and the visible presence or absence of mould in silage does not confirm the presence or absence of mycotoxins.

## 2. Questions addressed by the project:

- Can we develop an accurate, precise and robust multi-mycotoxin assay for silages?
- How best should baled and pit silages be sampled to obtain a representative sample for mycotoxin analysis?
- What are the incidence and concentration of key mycotoxins in Irish farms silages?
- What silage chemical composition traits are associated with mycotoxins in silage?
- What on-farm practices and management are associated with mycotoxins in silage?
- Does the type and amount of mycotoxin differ between the silage in the feed trough, at the silage feed face or deep within the core of the stored silage?

## 3. The experimental studies:

- Develop an ultra-high performance liquid chromatography tandem mass spectrometry (UHPLC-MS/MS) multi-mycotoxin analytical method to simultaneously identify and quantify 20 mycotoxins in grass silages, inclusive of mycotoxins that are currently regulated in EU feeds.
- Identify required procedures for representatively sampling silages for mycotoxins.
- Survey on-farm practices and silage mycotoxin and conventional chemical composition characteristics for a sample of farms within Co. Meath.
- Survey on-farm practices and silage mycotoxin and conventional chemical composition characteristics for a representative set of farms throughout Ireland. Undertaken on 150 farms in each of two successive winters.

## Main results:

- A quantitative UHPLCMS/MS method has been developed and validated for the simultaneous detection of 20 mycotoxins in grass silage and includes all eight EU regulated feed mycotoxins.
- The required intensity of sampling may be orders of magnitude greater when producing a representative sample of silage for mycotoxin analysis rather than for nutritive value or preservation trait analysis.
- Mycotoxins produced by moulds active in crops growing in the field were more prevalent than those produced by moulds active within silage.
- Mycotoxins produced in the silo (or bale) rather than the field were more unevenly distributed within silage, and required more intensive sampling to obtain a representative sample.
- Mycotoxins recorded when silage was in the feed trough were most likely produced in the field or silo rather than in the trough.
- Conventionally measured indices of silage nutritive value (e.g. digestibility, fibre, protein) or preservation (pH, lactic acid, volatile fatty acids, ammonia-N) did not predict EU regulated mycotoxins. Relationships with other mycotoxins were also generally low ($R^2$<0.3).
- Although a wide range of pre- and post-mowing practices and management were studied, only a limited set of general associations with the incidence or concentration of the 20 measured mycotoxins were identified. The occurrence of pre-mowing *Fusarium* mycotoxins detected in this study generally increased with harvesting month (May-September) for both pit and baled silages.



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Post-mowing *Penicillium* mycotoxins (andrastin A, mycophenolic acid and roquefortine C) were more likely to be present when this mould was visible on baled silage. In pit silages, a rotted top layer was associated with these same mycotoxins.

- The incidence and concentration of the 20 measured mycotoxins were generally low in silages throughout Ireland, and the individual EU-regulated mycotoxin concentrations recorded were considerably lower than current EU directive or guideline thresholds.

## 4. Opportunity/Benefit:

The expected low challenge from individual silage mycotoxins to livestock and livestock products strengthens the marketing of Irish meat and milk products as quality assured. The low challenge also means that where farmers apply good silage production, storage and feedout practices they should not need to administer dietary agents to combat mycotoxins.

Mycotoxins capable of being transferred by ruminants into animal products (e.g. ochratoxin, aflotoxin B1) were not detected in Irish silages.

## 5. Dissemination:

### Main publications:

McElhinney, C., Danaher, M., Elliott, C.T. and O'Kiely, P. (2015) 'Mycotoxins in farm silages - a two year Irish national survey', *Grass and Forage Science*. (in press).

McElhinney, C., Danaher, M., Grant, J., Elliott, C.T. and O'Kiely, P. (2015) 'Variation associated with sampling a silage bale or next-to-be-fed section of pit silage for mycotoxins and conventional chemical characteristics'. *World Mycotoxin Journal*, (under review).

McElhinney, C., O'Kiely, P., Elliott, C.T. and Danaher, M. (2015) 'Development and validation of an UHPLC-MS/MS method for the determination of mycotoxins in grass silages'. *Food Additives and Contaminants*, (in press).

### Popular publications:

McElhinney, C., Danaher, C., Elliott, C. and O'Kiely, P. (2015) 'Mycotoxin characteristics of farm silages: A two year Irish national survey'. *Proceedings of the XVII International Silage Conference*, 1-3 July, Piracicaba, Brazil, p246-247.

McElhinney, C., Danaher, M., Elliott, C. and O'Kiely, P. (2014) 'Identification and quantification of mycotoxins in silages: a farm survey in Co. Meath'. *Proceedings of the Agricultural Research Forum*, 10-11 March, Tullamore, p91.

McElhinney, C., Danaher, M., Elliott, C. and O'Kiely, P. (2014) 'Mycotoxin and chemical characteristics of silages collected from horizontal silos on farms in Co. Meath, Ireland – a pilot study'. *Grassland Science in Europe*, 19: 610-612.

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