Healthy Silage Event: Part 2

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Last autumn, the Bovmycotox project hosted an event for farmers and advisers at Duchy College, looking at healthy silage and bovine mycotoxicosis. In our last edition, we published an overview of the whole day, but here we detail the talk by Professor Mike Wilkinson from the University of Nottingham in full.

Prof. Wilkinson explained that healthy silage has low levels of undesirable bacteria (*Enterobacteria*, *Listeria* and *Clostridia*), yeasts and moulds, mycotoxins, nitrate, amines and ammonia and aerobically spoiled material. *Enterobacteria* (coliforms), derive from soil, slurry and manure, and grow in the early stages of ensiling, when the pH is above 4.5. They act to reduce nitrates to nitrites, nitrous oxide and ammonia, and *Escherichia coli* 0157 can survive poorly fermented silage and cause acute diarrhoea and death. Even if the bacteria themselves don't survive the ensiling process, remnants of the bacterial cell walls can cause haemorrhagic lesions and liver damage – a disease known as endotoxicosis.

Listeria is probably one of the better known bacterial silage contaminants and is found in soil. Listeria proliferates in wet silage, with a pH above 4.5, and in the presence of oxygen. The geometry of round bale silage means that 70% of the total volume of silage is within 20cm of the surface, and is thus susceptible to the entry of oxygen, which can allow for mould growth to occur. Bale wrap is usually permeable to oxygen and this, together with wetter silage on the underside, creates ideal conditions for *Listeria* growth. Mouldy silage is very indicative of the presence of *Listeria*, and should not be fed to livestock.

Clostridia are responsible for the secondary fermentation of lactic acid into butyric acid, amines and ammonia. An environment in the silo or bale that is wet, with no oxygen and a pH of more than 4.5 is conducive to clostridial growth. They can reduce silage intake, with increased risk of clinical ketosis in cows in early lactation. *Clostridia* can contaminate milk and cause 'secondary blowing' of cheese, which destroys the product, with a huge financial impact. This issue is so

Professor Mike Wilkinson

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significant that in some key cheese producing areas of Europe, silage cannot be fed to cows where hard cheese is made or where cheese is made from unpasteurised milk. To reduce *Clostridia* contamination, grass should be mown in the dry and wilted well to remove excess water. Silage containing dead carcasses can be contaminated with *Clostridium botulinum*, which can cause botulism.

Prof. Wilkinson then went on to discuss yeasts and moulds. Yeasts are dormant in the silo, due to the lack of oxygen and the low pH. However, when the silo or bale is opened up and the silage is exposed to oxygen again, the yeasts are revived and aerobic spoilage (rotting) ensues. This can then set off a succession of events, including the proliferation of aerobic bacteria and moulds, an increase in temperature and a resulting loss of digestible nutrients. This cascade of events can also culminate in the production of mycotoxins and visible mould is a strong indicator of the presence of mycotoxins.

Prof. Wilkinson explained that as well as being produced in re-heated mouldy silage, mycotoxins can also be produced in the field, pre-harvest. He reiterated the point that mycotoxicosis is difficult to diagnose, with signs including reductions in intake, production, immunity and fertility. Prof. Wilkinson explained the differences in mycotoxins and highlighted that Deoxynivalenol (DON), which is the most common mycotoxin found in maize silage, is the only mycotoxin to be detoxified in the rumen (Table 1).

The Hy-Sil Project was then described, which was a precursor to Bovmycotox, involving many of the same project partners. Hy-Sil studied 45 farms across the south west of England. The project looked at a range of parameters, including average visible silage waste and average feed-out rates (metres/week). Silages produced on the farms were tested for eight mycotoxins and a mould count was carried out. It was found that 90% of the maize silage samples and 71% of the total mixed ration (TMR) samples contained mycotoxins, with DON having the highest incidence (97% of positive samples) and was most prevalent, accounting for 83% of the total mycotoxin concentration in maize silage and 63% of the total mycotoxin concentration of TMR samples. The next most significant mycotoxin was Zearalenone (ZON). There was no relationship between the silage mould count and total mycotoxin concentration, suggesting that the mycotoxins might have been formed on the maize crop in the field pre-harvest.

These results were extremely interesting, as these 45 farms were well managed, with low visible silage wastage and weekly feed-out rates within the ideal target of 1-2m per week in winter. These farms were doing things well, but were still experiencing high levels

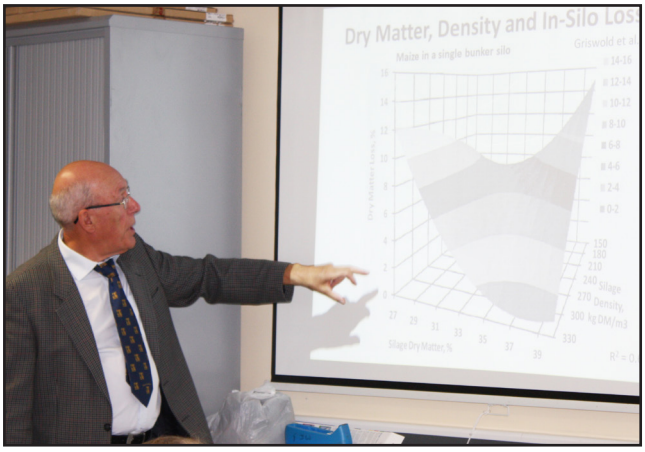
Table 1: Mycotoxins listed by originating fungal species. Table courtesy of Prof. Wilkinson.

Fungal species	Toxins	Origin	Detoxified in rumen
Aspergillus (grey)	Aflatoxin, Gliotoxin	Field and Silage	No
Fusarium (white or red/brown)	Deoxynivalenol (DON) Zearalenone (ZON) Fumonisin B1	Field Field Field	Yes No No
Claviceps purpurea (dark brown)	Ergotamine	Field (rye, wheat, barley, triticale)	No
Penicillium (blue-grey)	Roquefortine C	Silage	No
Penicillium	Mycophenolic acid	Silage	No

of mycotoxins.

Levels of mycotoxins within the silage samples ranged from 0 to 7,111 µg/kg for DON (with an average of 603 µg/kg) and from 0 to 3,901 µg/kg for ZON (with an average of 209 µg/kg). This put 72% of maize silage samples in medium and high-risk categories for mycotoxicosis. Concentrations of mycotoxins were lower in the TMR samples, with 69% of TMR samples in the zero to low risk categories.

Prof. Wilkinson went on to explain that physical damage to maize ears in the field can significantly increase the mycotoxin concentrations at harvest. An experiment was carried out in the USA where maize ears were slashed with a knife 9 days prior to harvest and other ears were similarly damaged 27 days prior to harvest. The silage was tested after 95 days in the silo, and it was found that the silage produced from ears that had been damaged



the longest (27 days) had significantly higher mycotoxin concentrations than the silage produced from the ears that had only been damaged nine days pre-harvest. This silage in turn had higher levels of mycotoxins than the silage made from undamaged ears (Table 2). This has serious implications for farms where damage to maize plants by deer or badgers is a regular occurrence.

Prof. Wilkinson then warned of the dangers of nitrogen dioxide (NO_2), which is visible as a reddish-brown gas escaping the silage clamp soon after ensiling. As NO_2 is heavier than air, it creeps along the ground. It poses a significant risk to health as when combined with water droplets, it produces nitric acid. If inhaled, it can cause breathing difficulties and lung damage, so the advice was clear, stay away.

Other unwanted contaminants of silage include amines and ammonia, which are linked to low silage intakes and the poor utilisation of nitrogen by the animal. They are produced by *Enterobacteria* and *Clostridia* (please see above), and are associated with wetter silages.

The talk then moved on to look at aerobic spoilage, which is increased by delayed sealing (longer than 24 hours) and by oxygen ingress through the silo covering film during storage. Aerobic spoilage is also higher in silages with low densities (<200 kg DM/m^3) and where there is a slow feed-out progression rate of less than 1 metre per week. This is due to the fact that more of the face is exposed to air for longer where the feed-out progression rate is slow.

Prof. Wilkinson recommended the use of oxygen barrier film, which was originally developed by the food industry for packaging and is virtually impermeable to oxygen. In trials of the film, it was found to reduce the loss of dry/organic matter in the top layer to 11.4% of crop ensiled, compared to 19.5% with standard

Table 2: Resulting levels of mycotoxins in silage produced from undamaged maize ears, ears damaged 9 days pre-harvest and 27 days pre-harvest. Table courtesy of Prof. Wilkinson.

Mycotoxin (µg/kg)	Undamaged	Damaged 9 days pre-harvest	Damaged 27 days pre-harvest
DON	300	705	21605
ZON	1040	1320	7220
Fumonisin B1	1730	1555	3035

plastic. This represents a significant reduction in spoilage. Other trials showed a reduction in the percentage of inedible dry matter when using oxygen barrier film, from 10.7% with standard plastic, to only 2.96% inedible silage with the barrier film. There are additional benefits, including a reduction in the labour required to sort and discard spoiled silage and also a reduction in the likelihood of accidentally feeding inedible silage.

"If your silage making and feeding operations aren't safe, nothing else matters"

Prof. Wilkinson listed some best practice guidelines for feeding silage, which included placing it in the trough as soon as possible after removing it from the silo and taking care to avoid putting any spoiled silage in the trough. You should aim to offer a little more than the animals are likely to eat, but troughs should be cleaned out daily before being re-filled. "It is also very important not to offer any rejected silage to other livestock, as it may be contaminated with toxins and cause disease", he said.

The importance of a good feed-out progression rate was reiterated with the example of a study in Germany of maize silage fed to goats. The study showed that the dry matter intake of the goats declined as the length of time the silage was exposed to air increased. After it had been exposed to air for eight days, the dry matter intake of the goats was less than half of what it was for silage that had only been exposed to air for 0-2 days. "This is significant for clamps with wide faces", said Prof. Wilkinson. "If you take a block out each day and take a week to move across the whole clamp face, the area where the first block was removed has been exposed to air for eight days by the time you return to it".

Prof. Wilkinson concluded his presentation with a brief discussion on silo safety, an area which is often overlooked. With many farms increasing herd sizes due to falling milk prices, it is often only cow accommodation and parlour size that are looked at in terms of infrastructure improvements. However, many silage clamps are old, too small and are consequently over-filled. Many do not have a safety rail and there is a risk of falling on to concrete when working on top of the clamp to discard spoiled silage or pulling back covering film. Indeed, many injuries and some deaths have occurred from falling from silage clamps. Prof. Wilkinson advised that when working on a silage clamp it is important to keep a safe distance from the feed face and the silo height should not exceed the reach of the unloading equipment, as there is a danger of an avalanche. The silo should be well lit, and you should avoid working alone around silos. "Remember, almost all Health and Safety prosecutions result in convictions, with the average fine in 2014/15 being £25,000", he warned. "If your silage making and feeding operations aren't safe, nothing else matters", he concluded.

For more information

The Bovmycotox project is funded by the Biotechnology and Biological Sciences Research Council (BBSRC) and is a joint collaboration between academics at the Universities of Bristol and Nottingham, Imperial College London, Rothamsted Research and Duchy College, and industry partners, Mole Valley Farmers, Micron Bio-Systems and AB Vista. The long-term aim of the project is to develop a rapid diagnostic tool for bovine mycotoxicosis.

For more information on the Bovmycotox project, please visit the project website www.bovmycotox.co.uk, call 0845 458 7485 or email rbs@duchy.ac.uk.