Silage health and animal welfare – more than meets the rumen

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Farms across Europe are recognising the 'all round' benefit of producing quality silage on the direct profit of their farms – the greater the silage quality, the less the replacement feed costs and generally the greater the animal performance. These direct benefits are well recognised, but what of the indirect benefits?

The quality of farm produced silage impacts many aspects of the dairy animal, not only nutrition (see Fig. 1). The 'health' of the silage directly impacts the welfare of the animal, and therefore the profitability of the farm. Recognising this fact immediately allows the farmer to mediate a solution. Equally, recognising which animal issues are not associated with silage will allow the farm to appropriately respond to animal issues. The impact of mould and mycotoxins is of enormous importance and is well recognised on farms, but what of other microbial issues?

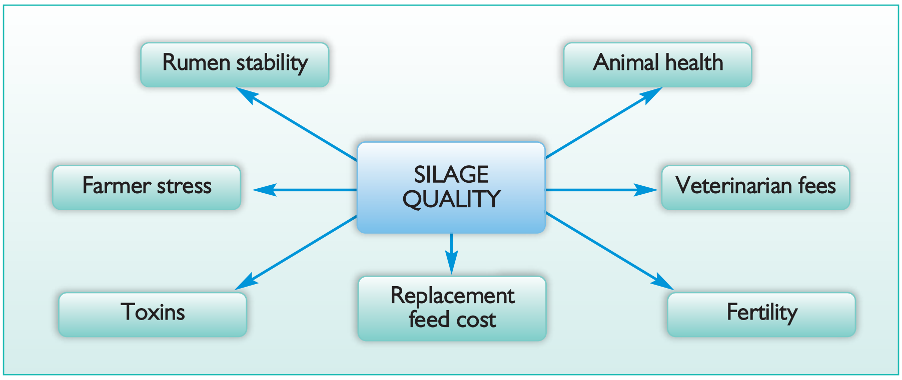


Fig. 1. The impact of silage quality.

Sub acute rumen acidosis

One issue that all farms suffer from is Sub Acute Rumen Acidosis (SARA). SARA is very rarely associated with the lactic acid level of silage – it is in fact caused by excessive production of propionic, acetic and butyric acids in the rumen (the main volatile fatty acids), and an inability of the rumen to absorb these acids quickly enough, driving the rumen pH down. This is often associated with low physically effective fibre and/or high cereal content in the diet. It is a mistake to blame a good homolactic fermentation for SARA, and doing so limits the ability of the farm to overcome the true issue – ration balancing.

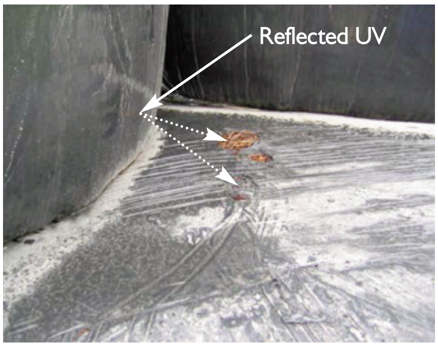
Biogenic amines can be formed within silage through protein decomposition (and can also be produced by rumen microflora).

Biogenic amines (histadine, putrescine, cadaverine, spermidine, tyramine etc) can be formed in 'high protein forages' such as alfalfa and clover through protein decomposition but also in maize through decarboxylation of amino acids by various bacteria. Biogenic amines have been linked to various health issues inclusive of ketonaemia, systemic histaminosis and reduced nitrogen degradability.

A positive correlation exists between increasing dry matter and reduced biogenic amine concentration, and between a faster fermentation and reducing biogenic amine. Use of homolactic inoculant to increase the speed of fermentation can therefore benefit silage health and animal welfare with regard to biogenic amines (generally rumen microflora degrade low level ingested biogenic amines.

Enterobacteria are generally rapidly killed during the early stages of ensiling by the initial decline in pH, but when the silage is aerobically challenged either through the fermentation or through damage to the covering, the pH rises and Enterobacteria numbers can increase to the region of $\sim 10^8$ cfu/g. The initial Enterobacteria population at ensiling is often dominated by Erwinia herbicola and Rahnella aquitilis. These are rapidly replaced by other species, inclusive of Escherichia coli, Hafnia alvei and Serratia fonticola, with E. coli being the most significant threat to health (air penetration can come from a variety of causes from inadequate sealing, animal damage and even reflected UV/thermal reflectivity).

Double solar radiation from reflection melting stacked bale plastic.



Elevation of pH

The presence of air leads to compounding problems. Air penetration slows and even stops fermentation, leading to a non-stable, elevated pH, or to the elevation of the pH in localised areas, which in turn allows the outgrowth of other organisms/spores that are naturally present.

Clostridium tyrobutyricum is relatively acid tolerant and converts lactic acid to butyric acid and hydrogen, which in turn raises the pH of the silage and allows the outgrowth of other undesirable microbes.

Clostridium botulinum is relatively rare in silage as it is not acid tolerant, but, as a sporolating organism it is capable of outgrowth between pH 5.3 and 6.5 (which is typical of deteriorating silage) – generally the presence of C. botulinum is associated with an ensiled cadaver or cadaver close to point of air entry.

Just 1g of botulinum toxin is theoretically sufficient to kill 10 million people, and with the preferred method of feeding being TMR a small area of contaminated silage can affect an entire herd.

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Increased compaction at ensiling.

Butyric layer of lower DM forage.

Poor sealing with ongoing air stress.

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The advent of 'compactors' across Europe is leading to an increase in the density of silages, with concomitant improvement in fermentation and aerobic stability.

Somewhat ironically, this desired improvement in compaction is leading to an increase in 'butyric layers' within silage through the ensiling of variable dry matter forages.

Historically, it was accepted that silages below 30% dry matter would be prone to effluent production, but with the increased packing density achieved with compactors, the dry matter at which silage will produce effluent is increased (dependent of forage type and chop length). Forage is being ensiled with the same historic fluctuation of dry matter from field to field, and on occasions lower DM forages (circa 32-34%) are being so well consolidated that they produce effluent which fills the pore spaces and creates the ideal environment for a butyric fermentation (lower DM forages in Europe often being associated).

Silage health problems

Many of the 'silage health' problems can be traced back to the presence of air through ensiling, and the continued entrance of air into the forage through fermentation and storage. Air penetrates into silage to a varying depth dependent on the compaction of the silage and the size of the 'aperture' in the sheeting/between wall panels.

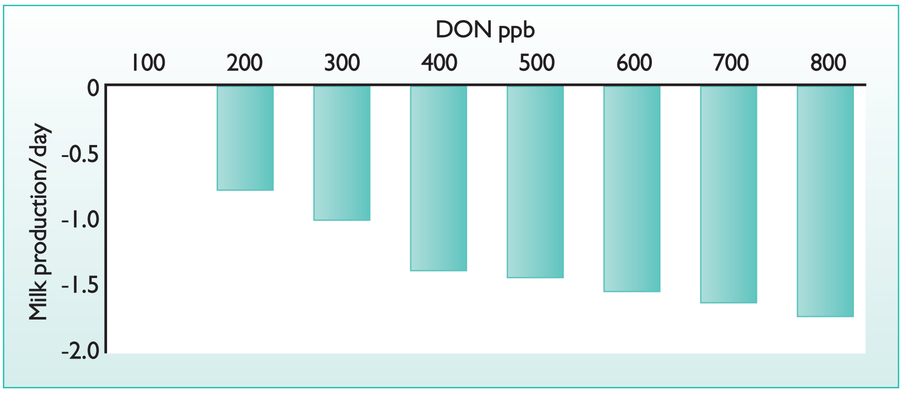
The aerobic conditions described also afford for the outgrowth of Listeria spp. Listeria is generally inhibited by an anaerobic environment and low pH, but when aerobically exposed it can survive at a pH as low as 4.2 and can lead to abortion, silage eye and other animal welfare issues as well as leading to the possible contamination of produced milk.

With aerobic exposure of silage, generally there is a visible proliferation on the surface of the silage – but this is only true if the aerobic exposure is at the surface of the silage. If air penetrates through side walls, the 'presence' can be invisible during feed-out, but dramatic to the animal.

And fungi? Mycotoxins are the fungal metabolites that all dairy and beef specialists are immediately conscious of. Mycotoxins have appropriately been well documented in many articles and only a short concession is made here. Formed either in the field and brought into the clamp through ensiling of contaminated forage, or through the out-growth of fungal spores within the silage, mycotoxins are a diverse range of chemicals that impact the dairy animal when present in low levels. There are currently over 400 known types of mycotoxins, which can be either 'field formed' or 'storage formed'. Many are field formed even when under optimal growing conditions and then ensiled, but the storage formed mycotoxins are typically formed when the source fungus is stressed (for example through a slow fermentation, the ingress of air etc). Fortunately, the rumen is a remarkable organ that detoxifies significant levels of mycotoxins through the action of naturally present protozoa before the toxin can impact the animal, but this capability is limited by (and not restricted to) the type of mycotoxin present in the silage, the concentration of the mycotoxin, the rumen pH and the rate of feed transit.

The enormous fungal diversity that exists typically means that if one mycotoxin is found to be present, it is quite possible that other mycotoxins will be present in the silage (it is impractical to analyse for 400 different mycotoxins, and the sample of silage that is analysed will never be reflective of the entire bunker – either in the presence or absence of a specific mycotoxin).

Fig. 2. The impact of mycotoxins on milk production (Whitlow et al, North Carolina State University).



Forage cultivation practices

The practices that are adopted for forage cultivation greatly impact the field formation of mycotoxins:

- Tillage of the soil – ploughing of crop residue back into the soil reduces fungal infestation of the following crop. Equally, no-till systems increase the risk of fungal infestation and concomitant formation of mycotoxin on the standing crop.
- Repetition of planting – when the same crop is grown in a field the reservoir of fungae in the soil are able to maintain their population (and increase) as they have a consistent susceptible forage to grow upon. Equally, crop rotation breaks this pattern and leads to a reduction in fungal numbers.
- Crop variety – seed producers have produced varieties that have specific desired traits. They may be more drought resistant, high yielding, strong stemmed or possess increased resistance to disease.
- Crop density – the greater the crop density the more stressed the plant becomes and the more susceptible to mould, and the more likely to transfer mould spores between plants.

But once the forage is harvested and ensiled, it can then be prone to the management conditions previously described, which in turn can lead to the outgrowth of moulds (visibly or invisibly) and entry into the animal's diet with varied and dramatic possible impact.

Silage health is animal welfare. ■

References are available from the author on request