Quality silage and contamination by mycotoxins

In dairy cow diets, forages are the most important components representing more than 60% of the total daily feed intake. In order to increase nutritive values and digestibility of forages, corn silage is now widely used worldwide for its high and uniform nutritional quality (1.5 MCal/kg DM on average), ease of cultivation and high yields (up to three times more dry matter per hectare than grass).

by Julia Laurain, For Feed Specialist, Olmix. www.olmix.com

But many research studies observed that corn silage is the main contributor of mycotoxins ingested by cows. A survey run in 24 Dutch farms revealed that mycotoxins ingestion from ensiled forage was three times greater than for other feed ingredients.

A review of literature concludes that the total amount of mycotoxins from corn silage is often higher than the maximum concentrations allowed or recommended by authorities.

Several factors contribute to the high contaminations found in corn silage: higher development of moulds in stem and leaves compared to cob, conditions of harvest, storage conditions. Corn silage is often contaminated by a mixture of pre-harvest and post-harvest mycotoxins depending on temperature, water activity (aw), oxygen availability and pH conditions.

Pre-harvest conditions

Pre-harvest or field moulds develop during plant growth and maturation as humidity is high (>70%) and temperature fluctuates between days and nights, Fusarium being the major field species.

Cold, wet periods followed by dry periods favour the development of Fusarium graminearum, nivale, culmorum, poae and roseum mainly producing deoxynivalenol (DON) and zearalenone (ZEA).

Fusarium proliferatum and verticillioides mostly develop during hot and dry periods (higher temperature than Fusarium sp producing DON) followed by humid conditions. This leads to Fusarium ear rot, a major corn plant disease which produces fumonisins. Weather conditions play a major role in the production of mycotoxins in the field.

Many studies reveal that DON is the most frequent mycotoxin in corn silage and can be used as a marker of Fusarium mycotoxin occurrence. ZEA co-occurs with DON as they are both produced by Fusarium graminearum but surveys show that ZEA is often detected at lower levels than DON. Other Fusarium mycotoxins (enniatins, beauvericins, fusaric acids and moniliformin) are commonly detected but with a lower occurrence and level of contamination.

During very hot periods (>32°C), high humidity or drought stress, Aspergillus flavus can develop in the field even if Aspergillus are more known as post-harvest moulds.

Some cultivation methods have been identified for their impact on Fusarium development like selection of resistant varieties, management of crop residues, rotation, use of irrigation system to prevent drought, proper fertilisation and spread of pesticides (with public health concern) or bio-agents.

Insect damage can significantly increase contamination in Fusarium toxins and aflatoxins as it predisposes corn to fungal diseases.

Harvest conditions

No specific mould or mycotoxin develops specifically at harvest, but harvest conditions must be well adjusted to minimise aggravating conditions.

Several studies suggest that harvesting corn at an ideal dry matter, ranging from 30-35%, contributes to a reduced mycotoxin concentration, probably due to less time in the field compared with high-maturity plants and also because dry silage is more difficult to contaminate.

Continued on page 14

Fig. 1. Fusarium mould and toxins growth during post-harvest in silages (adapted from Wambacq et al., 2016 and Boudra et al., 2009). Development of mould (—) and production of mycotoxin (——) depending on silage storage conditions.
Continued from page 13

to compact so more predisposed to
the presence of oxygen and heating
leading to mould growth.

It is also highly recommended to
quickly seal silage to optimise
anaerobic conditions. The cutting
height must also be well adjusted to
minimise soil contamination that is
rich in Fusarium inoculum.

Post-harvest conditions

Post-harvest moulds generally grow
under lower water activity levels
compared to pre-harvest moulds.
During storage, many spontaneous
moulds can develop but not
necessarily produce mycotoxins,
meaning that the presence of
moulds is not a reliable indicator of
mycotoxin contamination.

Aspergillus and Penicillium are the
two main strains of post-harvest
moulds that develop in the presence
of oxygen. Aspergillus is more
frequent in tropical and sub-tropical
regions as it prefers higher
temperatures and mostly produces
aflatoxins.

Aflatoxin occurrence is generally
lower than other mycotoxins in well-
preserved silages, whereas high
concentration of aflatoxin can occur
when silages are stored in poor
conditions.

Mycotoxins are often quantified in
feed materials as they are of
particular concern regarding human
health. In fact, aflatoxins are the only
mycotoxins that can be significantly
transferred into milk in addition to
being highly carcinogenic.

Penicillium moulds can grow under
lower temperature, oxygen and pH
conditions compared to Aspergillus.

Mycophenolic acid and
roquefortines remain the major
mycotoxins produced by Penicillium,
whereas the PR toxin and patulin are
rarely detected.

Aflatoxin occurrence is generally
lower than other mycotoxins in well-
preserved silages, whereas high
concentration of aflatoxin can occur
when silages are stored in poor
conditions. When storage conditions are not
optimum, inoculum of pre-harvest
moulds like Fusarium will find
favourable conditions for their
proliferation, leading to an
important accumulation of Fusarium
toxins in the final diet (Fig. 1).

The use of preserving additives,
such as inoculant or organic acids,
will help to secure storage
conditions and prevent toxin
production at post-harvest but will
not have any impact on toxins
produced prior to harvest.

Consequences and
protection

It is now clear that most of the
mycotoxins found in corn silage are
already present prior to harvest, thus
Fusarium mycotoxins are the most
occurring mycotoxins in dairy cows’
diet, DON and fumonisins being the
major ones.

Fusarium toxins exert their effects
through three primary mechanisms
in dairy cattle: immunosuppression,
reduction in feed efficacy and gut
integrity, and alteration of
reproductive performance.

These three primary mechanisms,
even with a low level of mycotoxins,
provokes pathologies such as
decreased performance, lower body
condition, liquid faeces, increased
somatic cells counts and mastitis,
lameness, etc.

Even if good silage management
prevents the growth of moulds and
toxins during the post-harvest phase,
it is very difficult to control Fusarium
and toxin production prior to
harvest.

As a consequence, Fusarium toxins
constitute a major threat to dairy
health and performance, and the use
of a wide spectrum toxin binder, in
addition to good silage practices,
will efficiently protect dairy herds.

References are available
from the author on request