

Managing and preserving corn quality during storage in silos



CHEW KIN KEN and STEVEN TOH* discuss good storage practices to safeguard corn stored in silos from mould infestation and insect damage, to preserve its quality during storage.



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Introduction

Corn is one of the most routinely used ingredients in livestock diets, as it is an excellent source of energy and is easily digestible. In Asia, storing corn in silos is a common practice for many feed mills. Corn storage can vary from one to three months and sometimes storage period may be extended to as long as 12 months depending on the price and supply of corn.

Key challenges in corn storage – mould growth

The key challenges in corn storage are to effectively safeguard corn

from mould growth and preserve its quality throughout the storage period. Mould growth is a serious concern as it is one of the main reasons for the deterioration of corn quality during storage. Corn is an excellent source of nutrients for mould growth. The nutritional value of corn is reduced, as mould consumes the nutrients and decreases the energy content. Mould also produce toxic metabolites known as mycotoxins which have an adverse effect on the animals' health and performance. Moreover, feed millers can incur financial losses if corn becomes mouldy and unacceptable

for use in feed production, especially since the level of mycotoxins in finished feeds are regulated.

Factors affecting mould growth during storage

Moisture content and storage temperature are two major factors affecting corn quality during storage. Mould requires moisture to grow. Therefore, corn with high moisture content stimulates rapid germination of mould spores and its proliferation in the corn. The optimal moisture level can differ from one feed mill to another, depending on parameters such as storage temperature and duration. The corn moisture level during storage in Asia Pacific can vary from 11% to 17%.

Storage temperature plays another critical role in affecting the corn quality during storage. Mould can grow within a broad temperature range from freezing to 45°C. Generally, higher storage temperatures encourage mould growth which accelerates the deterioration of corn quality. *Fusarium*, *Aspergillus* and *Penicillium* are three common mold species found in corn storage.

Figure 1: Formation of white strips outside of silos as a result of moisture condensation.



It is critical to also consider relative humidity (RH) in silos during corn storage. When RH is low, the air can pick up moisture from the corn surfaces as it passes through the corn mass. However, when RH is high or closer to saturation (RH = 100%), corn can take up moisture from the air, thus, increasing the corn moisture content and making it more susceptible to mould growth.

Key challenges in corn storage - insect infestation

Insect infestation is another

challenge faced by many feed millers during corn storage. Insect infestations can result in huge losses to the feed millers. These insects damage corn by consuming nutrients, causing decreased nutrient and quality in the corn. The metabolic activities of insects increase the moisture content and temperature of corn, which further promotes mould growth and accelerates the deterioration of the corn quality. Additionally, these insects can act as carriers of mould spores and spread mould within the corn mass.

Figure 2: Carbon dioxide (CO₂) test results for Myco Curb Extend Liquid.

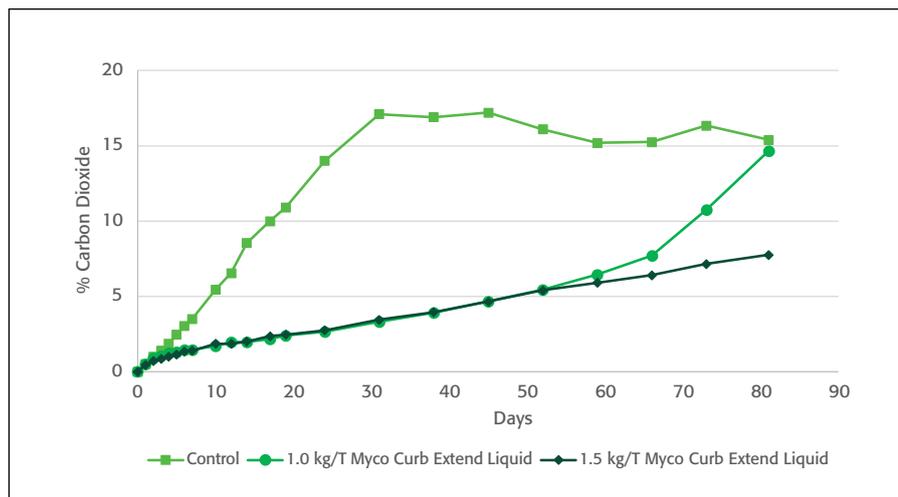


Table 1: Weight loss (%) of galvanized strips comparing control and Myco Curb Extend Liquid under accelerated corrosion test (65°C, 11 days)

Treatment	Percentage Weight Loss
Unbuffered propionic acid based mould inhibitor	54.58 %
Myco Curb Extend Liquid	11.87 %

Good storage practices

The key to successful corn storage and preservation begins with good storage practices, which are part of the quality assurance procedures to ensure that corn quality is maintained and preserved throughout the storage period. The overall goal of good storage practices are to control and maintain storage conditions in silos, to be unfavorable for the growth of spoilage organisms which can deteriorate the quality of corn.

Cleaning and inspection of silo conditions

Hygiene is the foundation of good corn storage. Silos should be cleaned, dry and well ventilated, before filling with new corn. Handling equipment, such as conveyors, aeration vents and hoppers should also be regularly cleaned, with the old corn and residues removed. It is important to have a schedule to periodically inspect and repair silos' roofs and walls such as cracks, loose or missing bolts and screws, or rust. Periodic inspection of the silos will not only ensure that the silos are in good condition, but it will also ensure that

the stored corn is protected from foreign materials and rain.

Corn drying and silo filling

Corn drying is needed if corn moisture level exceeds safe levels, as high moisture encourages mould proliferation. The drying or dehydration process helps to reduce the moisture content, thus retarding mould growth and preserving corn quality during storage. A heated air dryer is commonly used to dehydrate corn.

During filling, new corn should never be mixed with the old corn within the same silo to avoid cross-contamination and moisture migration, as new and old batches of corn have different moisture contents. Moreover, feed millers should avoid overfilling silos, as this will result in poor headspace ventilation which can lead to moisture condensation on the top of the corn mass.

Furthermore, it is crucial that fines are uniformly distributed in the silos during filling for optimal aeration. Uniform distribution of fines can be achieved with a spreader or by practicing repeated coring during the filling process. During the filling,

fines that are lighter than corn kernels will tend to accumulate at the centre of silos, and this affects ventilation efficiency during aeration. Coring is a process whereby corn is either discharged to production for immediate use or recirculated back to the grain sieve for removal of dust such that cleaned corn is returned to the silos for storage.

Aeration

Adequate and proper aeration is essential to maintain and preserve corn quality during storage. Corn is poor conductor of heat. During daytime, corn near the silo walls is hotter than corn in the centre as they heat up faster. During nighttime, corn near the silo wall is cooler than corn in the centre because it releases heat more rapidly. The temperature differences in the corn create convective currents which move moisture from the corn to accumulate at the top centre of the corn mass.

This moisture migration leads to condensation at the top of the corn, making it more susceptible to mould growth. The first sign of moisture condensation is damp corn surfaces, and sometimes in more severe cases, crusts are observed. Formation of white strips outside of silos are also signs of moisture condensation (Figure 1). These white strips are composed of corn dusts and are formed when the condensed moisture carries the corn dust and leaves stains on the sides of the silos.

Aeration regulates the temperatures of corn inside the silos thus mitigating issues brought about by moisture migration. Aeration is a process whereby air is forced and moved through the corn mass to reduce its temperature. Aeration helps to minimise and prevent the formation of hot spots in the corn mass. Thermometers can be installed at different parts within silos to monitor the temperatures of the corn to better determine when to start and stop aeration. It is important to note that aeration should not be executed when it is raining or immediately after raining, as this will introduce air with high RH into silos, allowing the corn to take up moisture from the air, increasing the risk of mould growth.

Insect control

Good storage practices of corn

cannot be achieved without insect control. Insect infestation is a common challenge faced by many feed millers. A common practice to deal with insect infestation is to fumigate silos. The fumigants commonly used are phosphides which can directly kill the insects. Fumigation is typically implemented after silos are emptied, and fumigants are retained in the silos for a required period to eliminate the insects.

Grain treatment program

It is insufficient just to have optimum storage conditions in silos, as it is also important to treat the corn such that it is well protected from mould growth. Storage conditions can differ from time to time, such as an increase in temperature in the afternoons or during summer seasons, or a rise in RH during rainy days. These can all lead to accelerated mould growth.

Kemin developed a grain treatment program with the use of Myco Curb Extend Liquid to offer maximum protection of the corn against mold growth. Myco Curb Extend Liquid is specifically formulated with a

synergistic combination of organic acids and is highly effective in inhibiting mould growth.

Carbon dioxide test

A carbon dioxide (CO₂) test was done to determine its efficacy against mould. This test measures the released carbon dioxide in a closed system where samples are incubated. Mould produces carbon dioxide during its metabolism. Therefore, the release of carbon dioxide serves as a direct indicator of mould activity in the samples.

The CO₂ test results are shown in Figure 2. With a dose of 1 – 1.5 kg/tonne Myco Curb Extend Liquid, corn is protected from mould growth for two months. A higher dosage may be required depending on the moisture and storage duration of the corn.

The formulation of Myco Curb Extend Liquid is optimised and buffered such that it has a near neutral pH, to allow safe handling and prevent corrosion to silos and equipment. An accelerated corrosion experiment was done by partially submerging galvanized metal strips in unbuffered propionic acid based

mould inhibitor and Myco Curb Extend Liquid at 65°C for 11 days. Table 1 shows the percentage weight loss due to accelerated corrosion (65°C, 11 days).

Conclusion

Mould growth and insect infestation are two main factors that contribute to deterioration of corn quality during storage in the silos. Good storage practices should be adopted to ensure storage conditions are unfavorable for growth of spoilage organisms, so as to preserve the quality of corn. For effective corn storage in the silos, Kemin has a grain treatment program with the use of Myco Curb Extend Liquid that is highly effective in retarding mould growth to ensure the corn quality is preserved throughout the storage period. **AF**

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