Mould and mycotoxin in the grain supply

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Cereals in general can be stored for long periods of time. The main objective of storing them is the preservation of an important volume of nutrients, which later on will be utilised by the primary users, the animal feed industry, in particular, feed for the poultry industry.

If storage conditions are inadequate and, insufficient preservation measures provided, this will cause serious quality and economic losses to the poultry industry due to loss of competitiveness in animal performance and ultimately increased production costs.

An imbalance in any of the aforementioned variables can result in mould growth, which can be the main cause for low quality grains. In the case of cereals, moulds are classified in two groups:

- Field moulds.
- Storage moulds.

Damage caused by field moulds occurs mainly during harvest and before moisture content is lowered.

These moulds require high moisture content for survival and they do not continue to spread during storage.

On the other hand, storage moulds, even though they are also present in the field do not generate serious problems until after grain is harvested.

At that point they begin to multiply inside broken and whole grains and continue growing until moisture content and/or temperature are sufficiently reduced to stop their growth.

Unless their growth is effectively stopped, they will eventually cause serious damage in the grain. As they grow, moulds use up nutrients in the grain, reducing their nutritive value. In their growing process and under favourable conditions, these moulds will also produce toxins.

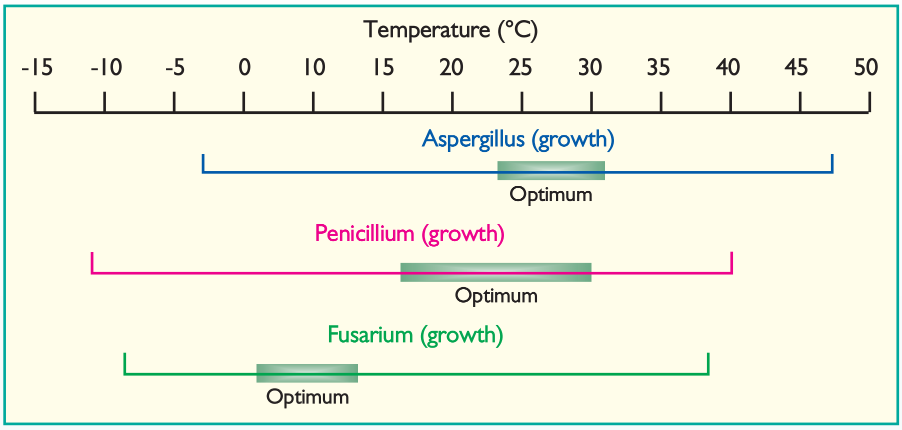


Fig. 1. Mould development.

Moisture

Grain moisture is foremost in importance for storing grains, since it is one of the main variables, which most affect mould rate of growth in cereals. Moulds do not grow at low moisture levels; growth begins at around 14% moisture content.

Between 14 and 20%, any slight change in moisture level will have a significant effect on the rate of mould development and in the ensuing species.

At first sight, a mass of grain in a silo or warehouse may appear uniform, when the opposite is true. It is also easy to assume that moisture content is consistent, when in fact it seldom is. However, one might expect that given enough time and under adequate storage conditions, the mass of grain will eventually reach a balance in its level of moisture content.

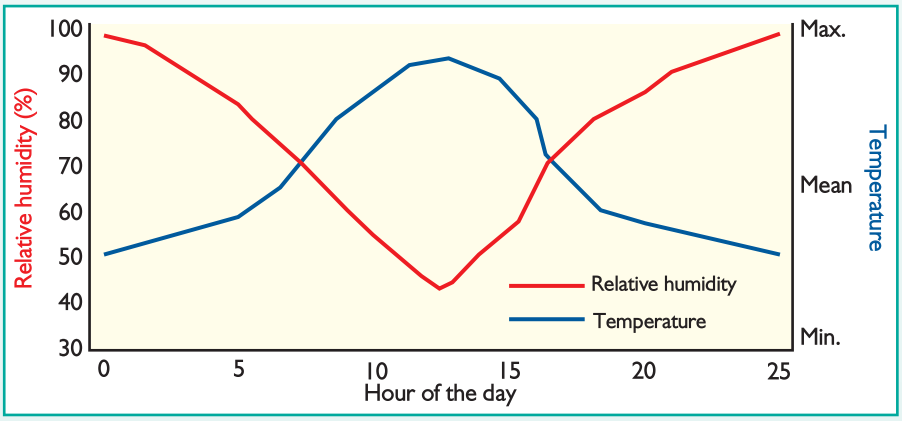
This is the reason why the measurement of moisture content must be accurate, but still more important, is to ensure that the sample being measured is really 'representative' of the grain lot under evaluation. In the specific case of grain storage, moisture content of each lot must be accurately verified.

Micro-organisms will develop in areas of the lot with high moisture content. In their growing process, the metabolism of these organisms produces moisture and heat, increasing their damaging effect.

Grain moisture is in balance with the air surrounding it. This balanced moisture content (EMC) is defined as moisture content in equilibrium with the atmosphere at given relative moisture. Different lots of grain, even of the same type of grain, may have different levels of moisture content in equilibrium.

Moreover, moisture content in grains of the same lot in an environment with the same relative moisture may vary, depending if the grains are gaining or losing moisture.

Fig. 2. The process of aeration.



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Finally, moisture migration inside the grain lot may be due to various factors: insect infestation, mould growth, temperature differential between the storage site (silo or warehouse) and the environment and in the case of silos, the effect of solar radiation heat on the outside silo surface.

The use of fans and air extractors to move dry and less hot air through the grain mass to remove the moisture surrounding it is one of the most effective means for preventing or controlling this problem.

We must bear in mind that moisture location and distribution in stored grain is more important than establishing average moisture of the stored mass, because an average does not reveal the presence of focal points or pockets with high moisture content.

Mould develops more rapidly between temperatures from 30-32°C and rate of growth decreases as temperatures drop. In addition to low temperatures, low moisture content is also critical for preventing fungal damage.

Temperatures from 5-10°C will drastically reduce mould growth rate, but will not entirely prevent growth. Although at lower rates, some mould will develop even at below freezing temperatures.

The Fusarium species grow successfully at low temperatures and toxin production is probably optimum at temperatures from 5.0 to 25°C.

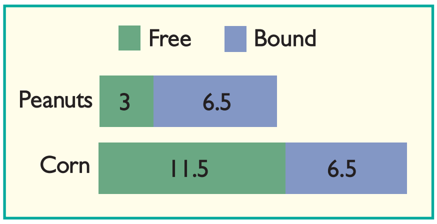


Fig. 3. Free and bound water in the total moisture of two grains.

In practical terms, this underlines the importance of reducing moisture levels as far as practically possible. We can state that the most important factors affecting grain mass temperature are:

- Environmental temperature.
- Heat generated by microbial metabolism. A high temperature cereal with 14-15% moisture content indicates insect or mould presence.
- Relative humidity.
- Quality and characteristics of storage site.

Aeration

This process involves moving a relative low volume of air through the grain to control its temperature and reduce the risk of damage in stored grain.

The two main objectives of aeration are:

- Maintaining an even temperature in the grain lot.
- Maintaining temperature as low as possible under practical conditions.

It is worthwhile mentioning that aeration systems must be evaluated based on:

- Type of grain stored.
- Moisture content of stored grain.
- Air flow rate.
- Selection of fan types.
- Air distribution designed for type of structure used.
- Desired time to cool the grain.
- Climatic conditions.

Improve risk management

Mould contamination levels observed in grains upon receipt in your feed mill will depend on existing conditions during harvest, handling, storage and transportation. It is very difficult to access the right information at the right time for the specific grain arriving at the feed mill.

In light of this, Cargill developed their MycoBMP tool to determine the level of risk (high, medium, low) for mould and mycotoxin contamination in a specific load of grain. This tool makes use of the information available to predict what level of risk we will have to deal with as we receive the grain.

However, this is not the end of the story. In order to satisfy the demands of the growers and maintain a constant supply flow, the poultry industry usually stores a minimum inventory of grains, soy meal and other ingredients.

The actual condition and management of the grain during this stage is also critical and should not be minimised when evaluating grain quality at feed out.

Since it is impossible to anticipate all these factors, for practical purposes it is recommended that grain importing countries apply a mould inhibitor at the moment of loading the ship.

On the other hand, grain producers should apply the mould inhibitor before storage after harvesting and drying the grain. This is the best insurance policy that customers can have against mycotoxins.

How can the most effective application rates for controlling moulds and toxins be determined?

Cargill offers its clients the service with their MycoBMP tool to determine the most effective application rate of mould inhibitor for the specific conditions of a given grain lot.

All the critical variables are analysed and a surface response model calculates the optimum doses for application under specific conditions. This is a robust model built not only from research data but the experience of grain users in our own feed mills.

Degree of insect infestation

Insects represent a serious problem when storing grains and raw materials in general. Not only do they consume part of the grain, but they also create a sanitary problem due to contamination.

The USDA estimates a yearly loss of around $500 million due to insect presence in stored grain.

The greater part of those losses could be prevented if existing information were adequately put into practice.

Insects can be divided in two categories:

- Those living inside the grain.
- Those living outside the grain.

As all living organisms, insects transform nutrients extracted from grain into carbon dioxide and water, generating heat during the process.

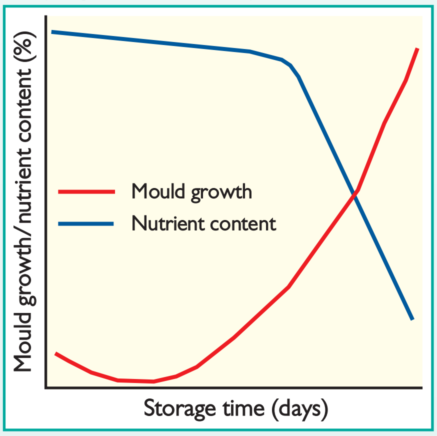
This increases temperature and moisture levels in stored grain. As they invade the grain, they break the natural grain protective barrier (integument), exposing the inside to mould contamination.

As they move throughout the inside and outside of the grain, they carry moulds, thereby facilitating even more mould contamination.

Broken grains, weeds, plant remnants and insect parts can also contaminate the grain supply. When grain is unloaded into the storage silos, the finer and lighter materials accumulate directly under the unloading pipe, creating air bags in the grain mass.

These turn into excellent culture media for moulds and insects. Thus, grain damage generally starts in this area of the silo or segment of the lot.

Fig. 4. Greater damage can occur during longer periods of storage.



Storage time

The longer the storage time, the greater the probability of developing favourable conditions for mould growth and insect infestation. It must be assumed that greater damage can occur during longer periods of storage. Even though the term 'storage' implies a still, static state, it is in fact, a very dynamic process.

Grains are living entities, with all the characteristics of a living organism and therefore, should not be treated as inanimate objects.

Organisms attacking the grain, or living in it, are also living things interacting with the grain during storage. This premise should always be borne in mind. ■