

Mold and Mycotoxins in Rabbit Feed

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1. What are mycotoxins?

Mold and **toxins from mold** can be harmful and even deadly to rabbits. Molds usually grow under specific conditions of temperature and humidity or in diseased/saturated soil. Moldy feeds may cause a variety of health problems in rabbits and humans, especially respiratory disease from breathing in mold spores. Moldy feeds are also less palatable and may cause a reduction in feed intake, resulting in weight loss.

When molds are shocked by sudden fluctuations in temperature (freezes or hot spells), they exude poisons called **mycotoxins**.

Types of **mold** that can be found in rabbit feed:

- *Aspergillus* (yellow to yellow-green) -- found in corn, forages¹, cottonseed, soybean² and peanuts. Its toxin is carcinogenic, causes hemorrhaging of intestinal tract and kidneys, reduced feed intake and diarrhea, lung damage, diarrhea, liver cancer and kidney damage.
- *Rhizoctonia* (brown to black) -- found especially in clover. Its toxin causes salivation, diarrhea and bloat.
- *Claviceps* (brown to black) -- most common in grasses including wheat, rye and barley. Its toxin causes tremors and convulsions.
- *Penicillium* (green to green-blue) -- found in corn and small grains². Its toxins cause kidney damage, weight loss, reduced feed intake causing hemorrhaging of lung and brain tissue.
- *Fusarium* (white to pinkish-white) --- found in hays, forages, soybean and cereal grains². Its toxins cause feed refusal, acute gastrointestinal illness, immune suppression, diarrhea, enteritis, weight loss, hemorrhages of the large intestine, shock and reduced gastric and small intestine flow, necrosis of the GI tract, and death.

¹ Alfalfa hay is considered a forage.

² Rabbit pellets contain wheat middlings, soybean hulls and sometimes corn -- the "pathway" ingredients for mycotoxin contamination.

Mycotoxins are invisible, highly corrosive, deadly poisons which may persist in feed and hay even when the molds that produced them are no longer present. Mycotoxins are nearly all cytotoxic, disrupting various cellular structures such as membranes, and interfering with vital cellular processes such as protein, RNA and DNA synthesis. They destroy organ tissue by oxidizing protein, impact specific organs, and have immunosuppressive effects. Some of them produce acute toxicity, evidenced by digestive disorders or dermatitis, but many more are carcinogenic (capable of causing cancer), resulting in genetic mutations, or causing deformities in developing embryos. Mycotoxins can have very pervasive, yet subclinical, effects on animals' health that can easily go unnoticed. By the time the clinical symptoms of mycotoxin poisoning are observed, significant damage has occurred.

Improper harvesting (putting up wet hay), packaging (in air-tight plastic bags) and storage or prolonged shipping may enhance the potential for mold growth. Dirty harvesting, manufacturing/pelleting equipment and storage bins may contribute to mycotoxin contamination.

2. What are the symptoms of mycotoxin poisoning (mycotoxicosis)?

The symptoms are wide-ranging and similar to more well-known ailments. Mycotoxins may cause:

- **Gastrointestinal** problems (slowdown, [delayed stomach emptying](#), stasis/colic, hemorrhages of the large intestine, shock, reduced gastric and small intestine flow, necrosis of the GI tract, severe bloating, impaction, shutdown without blockage, refusal to eat, weight loss, increased water consumption, vomiting, enteritis).
- Internal **bleeding**, hemorrhages or bruising.
- **Stomach** ulcers, **mouth** sores.
- **Kidney** damage (nephrotoxicity).
- **Liver** damage (liver lipidosis, hepatic lesions/fibrosis/swelling, degenerative changes and dystrophy).
- **Central nervous system** problems (twitches, wobbling, convulsions, seizures, paralysis, spasms, tremors, incoordination, depression, headache).
- **Immunosuppression** (increased susceptibility to multiple bacterial and viral infections).
- **Cancer** (tumorigenesis).
- **Eye** problems (discharge, corneal ulcers, keratitis).
- **Lung** problems (pneumonia, lung lesions, pulmonary fibrosis, hemorrhages, respiratory distress, bleeding).
- **Glandular** problems (hypertrophy of the adrenal cortex glands).
- **Reproductive organ** problems (impaired ovarian function, cystic ovarian degeneration development, reproductive disorders, vaginal prolapse).
- **Heart** problems (damaged heart muscle, tachycardia).
- **Skin** problems (skin rash, ulcerations, lesions, burning sensation, sloughing of skin, photosensitization).
- **Bone marrow** and **spleen** problems (depletion/irreversible damage/necrosis of the myelopoietic cells in bone marrow and in splenic red pulp).
- **Blood** abnormalities (decrease in blood coagulation, hematocrit and white blood cell count, leukopenia, calcium-phosphorus imbalance).
- **Rectal** prolapse.
- **Vascular system** (increased vascular fragility, hemorrhage into body tissues or from lung).
- **Caustic effects** on mucous membranes.

Since few veterinarians are trained in toxicology, mycotoxicosis is usually misdiagnosed.

3. How can mycotoxin poisoning be diagnosed?

The poisoning may manifest as on-and-off, chronic or acute episodes, depending on the amount of toxic feed ingested and how consistently it was fed. The damage to internal organs is cumulative over a period of time. A high incidence of gastrointestinal upsets (impactions, etc.) and of disease associated with depressed immune function (*Pasteurella*, etc.) may be clues that a mycotoxin problem exists. Some clinical signs which may appear in a rabbit:

- Severe **pain** in the abdomen -- sudden onset, haunches flaring out, belly pressed against or writhing on the floor, bunny might be lethargic and hide in a corner.
- A radiograph (x-ray) series may reveal gut shutdown but **no physical blockage** (barium barely drips through), sometimes **severe bloating**. Often diagnosed as [GI stasis](#) or [stenosis](#) without identifying the underlying cause.
- Standard GI stasis treatments no longer work, GI motility drugs (Cisapride/Metachlopramide) lose their effectiveness either because the tissue along the GI tract is necrotic/damaged or because of the overwhelming deoxynivalenol([DON](#))-[induced inhibition of gastric emptying](#) via serotonin receptor sites.
- **Hypothermia** (low body temperature).
- **Blood abnormalities:** high BUN and creatinine levels, calcium-phosphorus imbalance (which may lead to chalky urine, organ calcification), abnormal levels of liver enzymes associated with kidney/liver failure; low hematocrit/RBC due to internal bleeding.

- **Ulcers** in the mouth (strange chewing and tongue motion, difficulty swallowing, teeth problems ruled out), stomach and esophagus.
- **Refusal to eat**, weight loss.
- Presence of **mucous** in the feces.
- Rough hair coats.
- Sometimes **paralysis** or twitching in hind limbs.
- Multiple bunnies fall ill simultaneously in the same household.
- Food tests positive for mycotoxins.
- An endoscopic examination may reveal **ulceration along the GI tract** but this procedure is difficult to do on small animals.
- **Necropsies** may show: GI bruising (often subtle), hemorrhages, stomach/GI ulcerations, mouth ulcers, kidney/liver damage (lesions, lipidosis, fibrosis, swelling, discoloration), rectal prolapse.

While many mycotoxins can be measured in environmental samples, it is not yet possible to measure mycotoxins in human or animal tissues.

4. What is the treatment for mycotoxin poisoning?

Sucralfate: Break one-gram tablets of Carafate (sucralfate) into quarters. Administer 1/4 tablet orally every 8-12 hours mixed with water. Drop the 1/4 tablet into a feeding syringe, hold your finger over the tip, add some water, shake it well until it is dissolved, then invert the syringe and bleed off the excess air before syringe feeding (from the side of the mouth, in the gap behind the front teeth). Ideally, it should be given on an empty stomach (one-two hours before meals). Sucralfate should be staggered 3-6 hours apart from other medications because it tends to bind with other drugs (including cimetidine = Tagamet), reducing their absorption and effectiveness. Although healing begins within one to two weeks, it should be administered for at least 3-4 weeks (sometimes up to 8 weeks) to make sure healing is complete. Do not miss a dose because it works cumulatively.

Sucralfate is a "cytoprotective" agent that binds to the ulcerated erosion sites to form a protective barrier and promote healing. This prevents bacteria from crossing through the damaged tissue along the lining in the GI tract and entering the bloodstream, which may cause septicemia (blood poisoning). It is a very safe and effective drug.

Antibiotics (injectable Penicillin G) to guard against bacterial infection and septicemia/toxemia.

Subcutaneous fluids (in mild cases) or IV fluids (in severe cases) to flush out the toxins. Treat for renal failure with supportive therapy.

If severe bloating occurs, the stomach might need to be pumped (carefully) to prevent it from rupturing.

Ask your vet whether other anti-ulcer drugs might be helpful. **Prilosec** (omeprazole), which suppresses the acid "proton pump" in the gastric mucosa, has proven very effective in treating ulcers in horses (the closest physiological model to a rabbit; both are single-stomached hindgut fermenters). **Zantac** (Ranitidine HCl), which reduces the production of stomach acid by inhibiting histamine, is much more effective than **Tagamet** (cimetidine).

Note: Bunnies may have sensitive GI tracts for awhile. Fluids and sucralfate should be re-administered at any sign of discomfort during the following months.

5. What should I feed a rabbit who is suffering from mycotoxicosis?

Do not feed old hay and pellets. Buy new feed, a different brand if possible.

Fresh veggies might be the only food the bunny can tolerate for several weeks (the fiber in hay might be too rough) due to its damaged GI tract. Provide a variety (kale, dandelion greens, romaine lettuce, carrot tops, dill, fennel, mint, etc.) several times a day.

Keep hay and clean, fresh water available at all times. Oat hay and oat seed tops might be the first things the bunny will want to eat.

Feed wheat bran soaked in warm water (with wheat germ and Quaker oats added for taste) then drained and cooled, once per day. This provides protein to help repair the damaged GI tract.

- The effects can be partially counteracted by an antioxidant such as vitamin E. Vitamin A, selenium and zinc, Thiamine and other B vitamins may prove beneficial. Milk thistle can be helpful in treating liver damage.
- Vitamin K1 (menadione) can be administered to stop internal bleeding.

6. How can I tell if my bunny's food is contaminated?

- Have all hay and pellets tested at an agricultural, university, or veterinary diagnostic laboratory near you (do **not** send samples back to the vendor).
- Mix the feed well before sampling. Mycotoxins are patchy, like "spots of mold on a loaf of bread". Mixing the feed well increases the chances of detecting these poisons but the tests might indicate lower levels than what the bunny actually ate (perhaps he ate from a "hot spot" of concentrated toxins). Keep two extra samples aside for further testing.
- Make sure you ask for numerical results in parts-per-billion (ppb), down to 50 ppb if possible. Many labs are geared for large, multiple-stomached ruminant livestock (like beef cattle) so their detection levels may be set way too high (500-1,000 ppb). In this case, a feed that tests "negative" may still be dangerous to single-stomached hindgut fermenters (like rabbits and horses), who are much more sensitive to mycotoxins. See table below.
- Test especially for DON (vomitoxin). It is a "marker" for other mycotoxins -- if it is present, then other mycotoxins are probably present as well. Test for DON, T-2, Aflatoxin, Fumonisin, Ochratoxin, Zearelanone (in that order of importance, depending on the money available for testing).
- When multiple mycotoxins are found together in a sample, their combined synergistic effect is usually more potent than any one alone.

Suggested Detection Levels for Mycotoxins				
Mycotoxin	Horses	Pigs	Children ages 1 - 4	Rabbits
Aflatoxin	50 ppb	20-100 ppb		20 ppb
T-2	50 ppb			50 ppb
DON	400 ppb	< 300 ppb	60 - 120 ppb	100 - 300 ppb
Zearalenone	100 ppb	100 - 200 ppb		100 ppb
Fumonisin	1,000 ppb			1,000 ppb

Make sure you choose a lab with detection levels as **low** as or **lower** than those suggested for rabbits (above). The lower the detection levels, the better, since rabbits are one of the most sensitive animals to these toxins. Be aware that some laboratories report test results in ppm.

ppm = parts-per-million
 ppb = parts-per-billion
 1 ppm = 1000 ppb

7. How prevalent are mycotoxins in animal feed?

Mycotoxin contamination is not an uncommon occurrence in pet foods, especially in (but not limited to) dog food. Corn, wheat middlings and soybeans are the usual "pathway" ingredients. In the past few years, there have been several cases of dog food which contained contaminated wheat middlings (the same ingredient found in many rabbit pellets). More than one hundred dogs fell ill and many died. Mycotoxins were found in two well known brands of dog food and the companies were forced to recall their products due to consumer pressure.

In a "sell it down the road" strategy, grain dealers often dump products which are deemed "unfit for human consumption" on the pet food industry to avoid suffering economic losses.

There are few standards or government regulations in place, so pet food companies rarely feel compelled to institute quality-control programs that detect mycotoxins in their products.

Of nearly 100 samples of rabbit feed (30 different products) from the caregivers of both sick and healthy rabbits, from pet stores, from vet clinics, and shipped directly by companies to customers, then tested by several laboratories around the country, 30% have tested positive for mycotoxins. Mycotoxins were found in alfalfa hay, timothy and alfalfa pellets, powdered food intended for sick/baby rabbits, and seed-based feed used by breeders. Recent laboratory test results suggest that the contamination is more prevalent among certain brands. 50% of one specific product contained mycotoxins.

The feeds which tested positive came from households where bunnies were sick or had died. Some samples which tested positive were not fed to rabbits. In two cases, the feed tested positive before the bunnies showed any symptoms; one of these rabbits died a couple of weeks later, both rabbits suffered severe kidney damage.

The mycotoxins found in rabbit feed so far were DON, T-2 and ZEAR. Keep in mind that there are more than 400 mycotoxins and these products were only tested for a few. More sampling, testing and analyses of the effects of mycotoxins on domestic animals are needed. If you have had or wish to have your feed tested, [please let me know](#).

The Color of Good Hay

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Dark Green - This is the color of well-grown alfalfa.

Light-to-Medium Green - The color of well-stored grass hay. The hay was carefully harvested and has a good amount of the nutrients needed.

Bright Lime Green - This usually denotes alfalfa hay that has been treated with propionic acid (a preservative), which will not harm a horse.

The Appearance of Good Hay:

Texture - Stems are shorter and thinner. The stems are easy to bend and are not stiff or brittle.

Stems & Leaves - Hays with a higher amount of leaves are more nutritious than hay which is mostly stems.

Weight - The bale should be light and easy to lift. If it is heavy, it may indicate that it is moldy or that rocks or dirt have been baled into it.

The Color of Bad Hay:

Light/Medium Brown - When the hay has a tint of brown, it contained too much moisture when baled and stored. Brown hay has a musty odor and cakes together. The bale is stiff and the strings have no elasticity.

Dark Brown or Black - The hay was exposed to rain or heavy fog and dew. This hay is very stiff and brittle, and has lost much of its nutrition.

Light Golden Yellow - The hay has been bleached by too much sun, or is aged. Usually only the outer layers become bleached. If the inside of the bale is yellow, most of the valuable nutrients have been lost.

The Appearance of Bad Hay:

Texture - The hay is stiff and brittle and the stems crack easily when bent. The bale may be heavy and/or hard to split into individual flakes.

Dirt & Mold - If the center of the bale appears matted together, and flakes are difficult to separate, it usually indicates dirt and/or mold. Avoid bales that have a gray tint and ones that are dusty when pulled apart.

Infestation - May be infested by rodents, blister beetles or other animals and insects. Always check every bale for this before feeding it to your horse. Discard any bales that you find animal parts in, no matter how small a part it is. Dead animal parts can carry serious diseases that are fatal to horses.

Weeds - If the hay contains a large amount of weeds and/or un-identifiable plants, do not buy it. Weeds may make hay less palatable, and may contain irritating contents such as burrs and thistles. The nutritional content of this type of hay is extremely hard to diagnose.

Other Important Points:

Inspecting Hay - Before purchasing hay from anyone, be sure to inspect a few bales. Buy a couple bales, cut them open and inspect them thoroughly. Check for mold, moisture, dirt, animal parts, insects, color, weeds, texture...and all of the above.

Consistency - Find a reliable dealer in your area that will supply you with hay year-round from the same fields. This will help decrease the likelihood of sickness or colic in horses that are sensitive to feed-switching. It will also help ensure that the nutrition you are giving your horse remains consistent as to not upset his sensitive digestive tract. Problems may arise if you regularly switch hay types, hay fields, and hay quality. Hiding

Bad Bales - Some hay dealers will pull a trick on many customers by hiding the bad bales in the middle of the load, where it is almost impossible to inspect them. They will sometimes put the best-looking bales (the ones you are most likely to inspect) on the outside. To avoid getting stuck with a load of hay like this, be sure to get the dealer's name, address and phone number, and inform him that you expect a refund or replacement for any bale of less quality than the ones you have inspected.

First-cut hay - When buying first-cut hay (hay that is the first cut of the year for that field), be sure to check for excessive moisture and weeds. First-cut hay can be the most nutritious if cut and cured properly, however, if it is not cut and cured properly it is likely to have excessive moisture and mold due to spring showers.

About the author:

Cheryl's goal is to educate horse owners on how to develop a trusting and respectful partnership with their horses. The training methods she uses and teaches are ones that promote a horse's confidence and willingness to please.