Vasoconstriction and heat stress caused by ergot alkaloids and fescue toxins

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Ergotism is one of the oldest known mycotoxicoses and the first documented epidemic of ergotism occurred in the middle ages when thousands of people died because of the 'holy fire'.

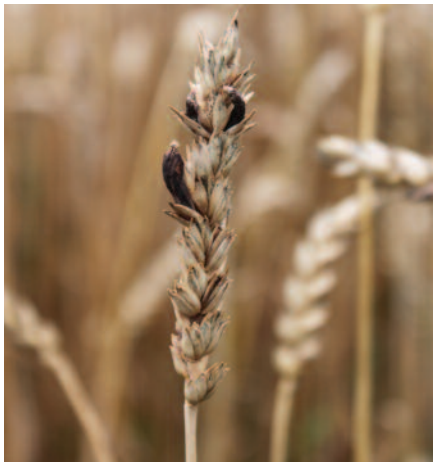
Ergot alkaloids (also named ergolines) exert toxic effects in all animal species, and the most prominent toxic signs can be attributed to the interaction of ergot alkaloids with adrenergic, serotinergic and dopaminergic receptors.

Information on the chemical and toxicological properties of individual ergot alkaloids is too limited at the present time for their selection as individual marker toxins when it comes to monitoring the extent of contamination. This means that neither the total alkaloid content, nor a single alkaloid can be recommended as reliable indicators of the potential adverse effects to livestock associated with the ingestion of ergot contaminated feeds.

Diverse group of toxins

Alkaloids have different and dose dependent receptor selectivity (binding affinity). Consequently, the biological effects of the various complex mixtures to which animals are exposed to, remain unpredictable.

The term ergot alkaloid refers to a diverse group of about 40 different toxins which are



Hybrid rye contaminated with ergots.

formed by Claviceps spp. on grains (rye (see photo), triticale, corn, wheat, barley, oats, millet, sorghum and rice) and by fungal endophytes such as Neotyphodium spp. in grasses, particularly tall fescue and perennial ryegrass, which adversely affects the health and productivity of livestock.

This fungus produces the ergot responsible for the ergot alkaloid group of mycotoxins and parasitises the seed heads of plants at the time of flowering.

Classifications of ergot alkaloid producing fungi are shown in Table 1. The main groups of natural ergot alkaloids are:

- The clavines, for example agroclavine.
- The lysergic acids.
- The lysergic acid amides, for example ergonovine (ergometrine, ergobasine) and ergine.
- The ergopeptines, for example ergovaline, ergotamine, ergocornine, ergocristine, ergosine and ergocryptine.

The ingestion of contaminated feedstuffs by the animals can have several sources ranging from contaminated farm equipment to contaminated seed line and feeding contaminated hay or silage.

Table 1. Classification of the main ergot alkaloid producing fungi.

Major classes	Fungi species	Mycotoxins
Claviceps	C. purpurea C. fusiformis C. paspali C. africana	Ergot alklaloids: clavines, lysergic acid, lysergic acid amids, ergopeptines
Neotyphodium (form. Acremonium)	N. coenophialum	Tall fescue toxins (endophyte toxins): ergot alkaloids, lolines, peramine
	N. lolli	Tall fescue toxins (endophyte toxins): lolitrems, peramine, ergot alkaloid (ergovaline)

Limit contamination

Good agricultural practices that limit contamination along with feeding compounds that have the capacity to bind these toxins are needed to reduce or eliminate the harmful effects.

These selected substances bind ergot alkaloids in the gastrointestinal tract, reduce their bioavailability and increase their excretion as an adsorbent toxin complex, thus helping control the negative impacts of these mycotoxins.

Ingestion of endophyte toxins in grasses, even at sub-clinical amounts is of concern in animal production. Perennial ryegrass endophytes (Neotyphodium lolii) together with the neurotoxin lolitrem B and the vasoconstrictor ergovaline are responsible for, among others, hypersensitivity in ruminants, impaired heat stress recognition, and vasoconstriction.

Chemical defence

Plant toxins are the chemical defence of plants against herbivores. Endophytic toxins in grasses include ergot alkaloids in tall fescue and tremorgens (for example lolitrem B) in perennial ryegrass.

Perennial ryegrass endophyte (Neotyphodium lolii) alkaloids are frequently present in pastures containing the neurotoxin lolitrem B, together with the vasoconstrictor ergovaline, at levels associated with ryegrass staggers, heat stress, ill-thrift and lowered milk production. It has been shown that some of the physiological processes such as fertility may be lowered following ingestion of alkaloids produced by Neotyphodium endophytes.

Animals can be exposed to complex mix-

Continued on page 31

Continued from page 29

tures of ergot alkaloids in many typical animal agriculture production systems. This exposure results from the fact that the kinds of alkaloids present and their levels can vary widely, depending on the fungal strain, the host plant and environmental conditions, being impossible to relate the exposure to individual toxins.

The chemically diverse group of ergot alkaloids has been shown in vasoconstriction symptoms, being responsible for heat intolerance as well as necrosis of ears, tails and often hooves.

Other symptoms, such as gangrenous changes, neurotoxic signs including convulsions, abortions and death, reduced prolactin secretion and consequently agalactia have been reported as major adverse effects in animals. Due to the fact that animals are exposed to a multiplicity of alkaloids when consuming endophyte-infected tall fescue, a combined alkaloid effect has been suggested by Klotz et al. (2008).

Chronic exposure to moderate amounts of ergot alkaloids results in reduced weight gain, low reproductive efficiency, including decreased conception rates, decreased circulating progesterone, and reduced signs of oestrus.

Experiments conducted in New Zealand indicate that cattle are slightly less susceptible to ergovaline toxicity than sheep with respect to live weight gain suppression (Table 2).

Threshold levels of ergovaline and lolitrem B have been established for cattle, sheep and horses (Table 3).

These levels, however, refer to the level of toxin in the total diet, not in single feed components.

	Ergovaline (ppb)	Lolitrem B (ppb)
Cattle	400-750	1.800-2.000
Sheep	500-800	1.800-2.000
Horses*	300-500	Not determined

*Except for mares in the last 60-90 days of pregnancy, when the threshold is zero.

Table 3. Threshold levels of ergovaline and lolitrem B in the diet able to produce a clinical disease.

Table 2. Biochemical criteria to diagnose potential ergot alkaloid toxicity.

Ergovaline	Animal	Toxic	Sub-toxic
Urine lysergol:creatinine	Sheep	>7.0	<4.0
	Cattle	>4.0	<2.5
Ergovaline intake (mg/kg $LW^{0.75}$)	Sheep	>0.08	0.03
	Cattle	>0.11	0.03
Pasture ergovaline (mg/kg DM)	Sheep	>0.9	0.3
	Cattle	>0.9	0.3

Mg/kg $LW^{0.75}$: milligrams per kilogram of animal live weight Mg/kg DM: milligrams per kilogram of dry matter intake

Conclusion

The use of high quality feedstuffs to reduce toxicosis of ergot alkaloids in livestock is the first step in avoiding problems they can cause, but to totally protect animals from the increasing risk of ergot alkaloid poisoning, a mycotoxin risk assessment is recommended. ■