Tall Fescue Toxicosis in Meat Goats

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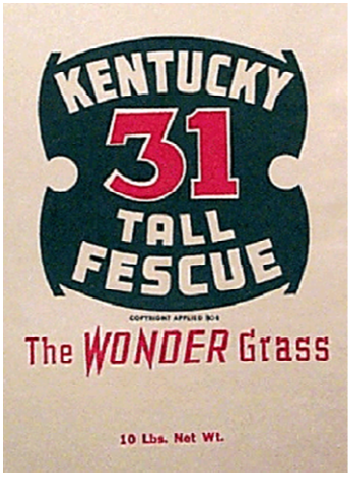
What is Tall Fescue?

Tall fescue (*Schedonorus phoenix* (Scop.) Holub) is a cool-season bunchgrass that grows throughout the eastern half of the United States and in the Pacific northwestern region of the country. It is estimated that over 90% of tall fescue pastures are infected with the fungal endophyte *Neotyphodium coenophialum* (Bacon and Siegel, 1988; Glenn et al., 1996). Tall fescue is native to Europe and was first brought to the United States in the 1800s. Two varieties of tall fescue were commercially released in the 1940s after years of study in Kentucky (Kentucky-31) and Oregon (Alta). The broad distribution of tall fescue across the country is a result of its early popularity for planting as both an erosion control agent and as pasture forage. Tall fescue was soon referred to as a 'Wonder Grass' because of its growth potential under adverse soil and management conditions. Tall fescue has a bimodal growth pattern typical of cool-season grasses with peak production in the spring and a secondary growth period in the fall. It is the predominant common grasses fed to livestock in the form of standing pasture or stored hay. Two-thirds of pastures used to graze goats were classified as tall fescue in a survey of Tennessee goat producers (Leite-Browning et al., 2002).



Tall fescue and the fungal endophyte share a natural, symbiotic relationship. The endophyte protects its tall fescue host from environmental stressors such as drought, insects, nematodes, disease pathogens, and grazing herbivores such as cattle and goats. The endophyte produces numerous chemical compounds responsible for both the positive plant hardiness traits and negative anti-livestock characteristics of tall fescue (Browning and Leite-Browning, 1997; Browning et al., 1997). The endophyte cannot be seen by looking at the grass in the field. Viewing of the endophyte requires placing a section of stain-treated grass tissue under a microscope. Healthy looking, vigorously growing fescue stands are the ones most likely to be highly infected with the endophyte.

What is Fescue Toxicosis?

Tall fescue is a forage of good nutrient quality, suggestive of satisfactory livestock performance. It was several years after the commercial release of tall fescue when concerns began to emerge about livestock underperforming on fescue pastures. Investigations into poor animal performance led to the discovery of the fungal endophyte that infected the grass in the 1970s. Endophyte discovery was followed by the identification of chemical compounds, ergot alkaloids in particular, produced by the endophyte and subsequent characterization of their effects on plant and livestock performance.

Problems in livestock associated with endophyte-infected (EI) tall fescue consumption include: 1. fescue foot, 2. fat necrosis, and 3. fescue toxicosis. Fescue foot is a condition in which animals become lame with potential loss of hooves and tips of the tail and ears under cold winter conditions. Fat necrosis is the development of hard fat deposits in the abdomen that can interfere with digestion or parturition. Fescue foot and fat necrosis are infrequent occurrences. Fat necrosis has been documented in a goat on EI tall fescue (Smith et al., 2004).

Fescue toxicosis is a complex syndrome that is generally not fatal. However, major disruptions of normal body function can occur. Ergot alkaloids cause numerous physiological alterations that impact various systems of the body. The basic chemical structure of the ergot alkaloids has similarities to the major neurotransmitters (brain chemicals) dopamine, norepinephrine, and serotonin. When consumed, the ergot alkaloids alter systems of the body that are controlled by these neurotransmitters. Affected systems include appetite control, heart and blood vessel function, hormonal activity, gut motility, muscle contractions, and body temperature regulation.

Signs of fescue toxicosis vary among livestock species (Porter and Thompson, 1992). Visible signs in animals consuming EI tall fescue include rough hair coats, heat stress, and suppressed appetite. These signs are not always presented. Fescue toxicosis is often subclinical with the only subtle but important changes being lower growth or reproductive rates. Fescue toxicosis costs the U.S. beef industry an estimated $500 million to $1 billion annually in lost revenue because of reduced reproductive and growth rates in cattle herds. Economic impact on the goat industry is unknown.

Do Goats Experience Fescue Toxicosis?

Few studies have assessed fescue toxicosis in goats. The available goat data have focused on weight gain. Endophyte-infected tall fescue reduced weight gain in goats when compared to endophyte-free tall fescue (Table1). The effect was less pronounced in suckling kids. The reduction of weight gain in young goats after weaning and as yearlings fed EI tall fescue is similar to the responses reported in lambs (Chestnut et al., 1992; Parish et al., 2003). Lowered growth rates in goats consuming EI tall fescue can be costly when developing market kids or replacement breeding stock.

Does selectively limited their consumption of seed highly infected with endophyte (Table 1). Ergot alkaloids are highly concentrated in the tall fescue seeds. Unlike the common observations of discomfort in cattle (Browning, 2004), symptoms of reduced health or well-being in goats on EI tall fescue diets were not seen by Luginbuhl (2007) or Browning (2012). It is not known if EI tall fescue adversely effects goat fertility. Goats typically breed in the fall and kid in spring. Thus the reproductive process, excluding the pre-weaning lactation period, is completed before summer when the negative effects of fescue toxicosis are most pronounced. There have been anecdotal producer accounts of anomalies during kidding similar to conditions documented in mares around foaling time (Porter and Thompson, 1992), including delayed delivery, thickened placentas, and weak offspring. Parturition responses to EI tall fescue require substantiation under controlled conditions.

Table 1. Growth rates and feeding behavior of meat goats fed endophyte-infected or endophyte-free tall fescue.

		Tall fescue type	
Study	Goat class	Endophyte-infected	Endophyte-free
		---------- Animal weight gain (lbs/day) ----------	
Browning, 2012[ab]	Yearling does *(Trial 1)*	0.08	0.16
	Yearling does *(Trial 2)*	0.08	0.15
Luginbuhl, 2007[c]	Nursing does	-0.20	0.13
	Pre-weaned kids	0.26	0.30
	Post-weaned kids	0.04	0.15
		---------- Unconsumed dietary seed (%) ----------	
Browning, 2012	Yearling does *(Trial 1)*	45	1
Luginbuhl, 2007	Doe-kid units *(Year 1)*	74	3

[a] Trial 1 = two years of equalized feed offering, Trial 2 = two years of equalized feed intake
[b] Tall fescue provided as trough-fed seed.
[c] Tall fescue provided as grazed pasture in three years.

What are Management Options to Mitigate Fescue Toxicosis in Goats?

Limiting or preventing ergot alkaloid consumption is the primary means of managing against fescue toxicosis. Much research has gone into seeking management options to address fescue toxicosis (Ball, 1997). Most of the work and subsequent recommendations have targeted cattle and horses. Some of these management options would be suitable for goats, while others are less appealing.

1. Dilute endophyte-infected tall fescue with other grasses or legumes. Other forages can be planted (interseeded) within an existing stand of EI tall fescue to lower the amount of ergot alkaloids animals will have available for potential consumption. It is a less expensive and easier option than a more drastic approach of EI tall fescue eradication. Goats prefer a mix of plant types and consume a diverse diet when variety is offered. The dilution of EI tall fescue is perfectly suited for goats. The ability of goats to consume a variety of grasses, legumes, and browse facilitates the dilution concept in a slightly different manner. If goats have access to wooded or brushy areas (or non-fescue pastures) along with fescue pasture, then their instinctual nature to diversify their diet will lower their daily ergot alkaloid intake. The seed refusal values (Table 1) highlight the selective feeding behavior of goats. Goats have an advantage over cattle and sheep in this regard as it relates to minimizing the fescue toxicosis risk. The dilution option should receive primary consideration for averting fescue toxisosis in goats by either interseeding alternative forages within an established fescue pasture (or encouraging multi-species plant growth within the pasture) or providing open access to brushy areas along with the fescue pasture. Feeding mixed grass hay that contains tall fescue along with other plant species also fits within the forage dilution concept.

Clover is often recommended as an EI tall fescue diluter. White clover in particular is very compatible with established tall fescue stands. Goats unfortunately seem to have a lower preference for eating clover than other livestock. This should be taken into account when

considering clover to dilute EI tall fescue for grazing goats. Lespedeza is a legume that seems to work well as a complimentary warm-season legume when interseeded in tall fescue fields.

2. Replace endophyte-infected tall fescue with another forage. Eradication of tall fescue from the pasture is the first option that typically comes to mind. The obvious upside is eliminating the ergot alkaloids from the grazing environment. However, there are several negative aspects to this approach. Remember that the endophyte may be bad for the grazing goat, but it is very good for the grazed tall fescue. The existing fescue may be very productive and outcompeting other forages to maintain dominance in a pasture. This highlights the early popularity of tall fescue as a hardy Wonder Grass. Replacing EI tall fescue incurs several costs and inconveniences. The time and expenses of eliminating the EI tall fescue and planting a new forage type, loss of pasture use for up to a year or more while the new grass becomes established, and uncertainty of whether the new grass variety will become adequately established for long-term forage production. Failure of a new pasture planting is a major economic setback. Some terrains, such as hillsides, may not be easily worked to establish new pasture. Such difficult landscapes are the very types where goats and EI tall fescue thrive. Forage replacement requires a long-term commitment to the enterprise with a reasonable expectation that the added level of goat performance will more than offset the resources expended to establish and maintain the new forage.

<u>*Endophyte-free and novel endophyte tall fescue varieties*</u>. Soon after discovery of the tall fescue endophyte, endophyte-free varieties were developed and distributed. Animal performance benefited from the absence of ergot alkaloids, but grass performance suffered. Forage yields were poor and stands were often short-lived, leading to producer reluctance to pursue further replacement of long-established, healthy EI fescue stands for grazing. More recent research has led to the development of tall fescue with new genetic strains of endophyte that produce altered chemical compound profiles (Panaccione et al., 2001; Bouton et al., 2002). These 'non-toxic' or 'novel' endophytes produce chemical agents that provide plant protection, but not the ergot alkaloids responsible for fescue toxicosis in livestock. Tall fescue infected with novel endophytes are commercially available and shows promise as a pasture management option for producers to overcome fescue toxicosis and enhance growth in sheep (Bouton et al., 2002; Parish et al., 2003) and goats (Luginbuhl, 2007). The vast acreage covered in EI tall fescue across the U.S. and the prohibitive cost of novel endophyte seed limit the extent to which this replacement option is adopted. This in addition to previously mentioned concerns such as the risk of new stand failure, land cultivation limitations, and time requirements for new stand establishment before first grazing.

Fescue replacement is a much easier approach when considering hay. Endophyte-infected tall fescue hay can be as problematic as the growing green grass in causing fescue toxicosis. Feed a hay that was produced from another forage type. Bermudagrass, orchardgrass, and numerous other hay types may be used.

3. Increase stocking rates on EI tall fescue pastures to prevent plant maturation and seedhead formation. Ergot alkaloids are found throughout the tall fescue plant, but highest concentrations are in the seeds. Goats like eating seeds. The objective of increased stocking rates is keeping the fescue grazed fairly close to the ground to deter plant maturation and seed production. This approach may not be as suitable for goats as for cattle or sheep because of the ever-present risk of internal parasites (gut worms) that are a far greater threat to goat health and production than ergot alkaloids. A critical component of parasite control in goats is avoiding pastures from being grazed close to the ground where the internal parasites are located. Another method of seed control is clipping (brush hogging) the pastures. Brush hogging close to the ground is also undesirable because of internal parasite control requirements. If goats have a diet of diverse forages and self-limit their EI tall fescue seed consumption, then seed production may not pose a toxic risk to the herd.

4. Avoid summer grazing and nitrogen fertilization. The greatest risk of fescue toxicosis is in the summer because of elevated ergot alkaloid levels in the forage coupled with elevated air temperatures that exacerbate the toxic responses (Browning, 2004). Avoidance of summer EI tall fescue grazing is a sound recommendation for goats. Grazing areas need to be available that offer alternative forages. An added reason to limit summer fescue grazing is the reduced forage growth and quality during this season. Goats may be placed back on fescue in the fall or winter after an accumulation of fall forage growth.

Fertilizing EI tall fescue with nitrogen is not advised. It increases the toxic nature of the forage. Nitrogen fertilization is further detrimental in fescue stands mixed with lespedeza. The nitrogen can reduce or eliminate the lespedeza from the pasture.

5. Alter nutritional management of the goat herd. A manager can provide the herd with some grain or pelleted feed. The feed substitutes for some of the fescue, thus lowers the level of ergot alkaloids consumed. This is somewhat similar to the dilution approach of replacing part of the fescue diet with other forages. The dilution here is with feed instead of another forage type. There may be extra benefits of added nutrients derived from the concentrated feed. Be careful not to over-feed the herd as animals may become over-conditioned. Concentrate feeding increases the annual herd management costs, reducing the chance of profit. Feeding should be limited if used as a control practice for fescue toxicosis.

Several mineral mixes are marketed for cattle grazing EI tall fescue. The premise is that mineral deficiencies play a role in fescue toxicosis. Copper deficiencies are well documented in cattle on EI tall fescue (Oliver et al., 2000). Some mineral mixes targeting cattle on EI tall fescue contain additives like seaweed or yeast products purported to combat fescue toxicosis. Effects of these additives on the performance of cattle grazing EI tall fescue have been experimentally inconclusive. More importantly, the effects of seaweed or yeast products on goats consuming EI tall fescue have not been researched. Exercise general caution when considering cattle mineral mixes for goats. They are not designed to meet goat nutrient needs. In any grazing situation, loose minerals formulated for goats (not sheep and goat combinations) should always be available for consumption.

Conclusion

Goats have an enhanced ability to rapidly eliminate plant metabolic chemicals from their body (i.e., detoxification) compared to sheep and cattle. There were thoughts that goats may not experience fescue toxicosis. Goats rarely, if ever, exhibited clinical signs recorded in other livestock on EI tall fescue pastures. The detoxification abilities of goats coupled with their selective feeding behaviors seem to place them at a lower risk of disappointing outcomes compared to other livestock foraging on EI tall fescue. Nevertheless, the research results in Table 1 indicate that goats can be adversely affected by EI tall fescue in a manner not readily recognized on a typical meat goat farm. The impact of EI tall fescue on the goats in the Tennessee or North Carolina studies (Table 1) would not have been detected without an alternative forage type for comparison and the recording of weight data.

Fescue toxicosis probably poses a minor threat to goat productivity as long as goats are not forced to graze pure EI tall fescue stands for extended periods. If EI tall fescue is the main forage, it would be useful to know the level of endophyte infection. There are diagnostic labs that can determine endophyte infection rates in properly collected grass samples. Low to moderate endophyte levels are generally not a problem. A few labs can test samples for ergot alkaloid concentrations. Ergot alkaloid levels are more informative than endophyte levels, but the latter is sufficient for risk assessment. Hay samples can be tested for ergot alkaloid levels, but not for endophyte levels.

Livestock research continues in the area of fescue toxicosis. Perhaps more of this experimentation will involve goats to further determine their responses to EI tall fescue and assess possible remedies when required in this expanding sector of animal agriculture.

LITERATURE CITED

Bacon, C.W., M.R. Siegel. 1988. J. Prod. Agric. 1:45-55.

Ball, D.M. 1997. *Neotyphodium*/Grass Interactions. pp 395-410. Plenum Press, New York.

Bouton, J.H., G.C.M. Latch, N.S. Hill, C.S. Hoveland, M.A. McCann, R.H. Watson, J.A. Parish, L.L. Hawkins, F.N. Thompson. 2002. Agron. J. 94:567-574.

Browning, R. Jr. 2012. Small Rumin. Res. 105:29-32.

Browning, R. Jr. 2004. J. Anim. Sci. 82:634-643.

Browning, R. Jr., M.L. Leite-Browning. 1997. J. Anim. Sci. 75:176-181.

Browning, R. Jr., F.N. Thompson, J.L. Sartin, M.L. Leite-Browning. 1997. J. Anim. Sci. 75:796-802.

Chestnut, A.B., J.K. Bernard, J.B. Harstin, and B.B. Reddick. 1992. Small Rumin. Res. 7:9-19.

Glenn, A.E., C.W. Bacon, R. Price, R.T. Hanlin. 1996. Mycologia 88:369-383.

Leite-Browning, M.L., S. Muhammad, R. Browning, Jr. 2002. J. Anim. Sci. 80(Suppl. 2):27.

Luginbuhl, J-M. 2007. 1st Annual Conf. on Small Ruminants, Forages and Grazing Management of Sheep and Goats. Alabama Coop. Extension System (Aug 23-24). 17 pp.

Oliver, J.W., A.E. Schultze, B.W. Rohrbach, H.A. Fribourg, T. Ingle, J.C. Waller. 2000. J. Anim. Sci. 78:1029-1035.

Panaccione, D.G., R.D. Johnson, J. Wang, C.A. Young, P. Damrongkool, B. Scott, C.L. Schardl. 2001. Proc. Natl. Acad. Sci. USA 98:12820-12825.

Parish, J.A., M.A. McCann, R.H. Watson, C.S. Hoveland, L.L. Hawkins, N.S. Hill, J.H. Bouton. 2003. J. Anim Sci. 81:1316-1322.

Smith, G.W., D.S. Rotstein, C.F. Brownie. 2004. J. Vet. Diagn. Invest. 16:356–359.

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