

# Influence of Alkaloid Concentration of Tall Fescue Straw on the Nutrition, Physiology and Subsequent Performance of Beef Steers<sup>1</sup>

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*Summary: Under the conditions of these studies, the endophyte-produced alkaloids associated with tall fescue straw did not cause health problems or reductions in animal performance. Dry matter intakes and digestive efficiencies were similar across all levels of alkaloids. In addition, no evidence of vasoconstriction or other physiological symptoms associated with fescue toxicosis were observed. Therefore, these studies suggest that properly supplemented low-quality straws up to 475 ppb ergovaline can be fed in winter feeding programs for growing and early to mid-gestating cows without depression in animal health, nutrition, or performance.*

*Circulating Prolactin levels were decreased, however, with high endophyte/alkaloid straw diets, indicating a possible subclinical effect. This observation suggests that further research is needed to evaluate the effects of high endophyte/alkaloid straw diets when fed to late gestating and lactating beef cattle.*

The presence of the fungal endophyte, *Acremonium coenophialum*, in tall fescue (*Festuca arundinacea* Schreb.), has been implicated in reduced animal performance and animal health problems such as fescue foot and fescue toxicosis. These animal performance/health problems are actually caused by alkaloids produced by a fungus that has been intentionally

bred into many types of grasses. The fungal endophyte improves plant vigor, as well as resistance to disease and pests. Thus, if the grass species is not intended for livestock consumption, presence of the endophyte actually offers agronomic advantages.

In the Pacific Northwest, a large volume of tall fescue grass seed residue is produced (over 200,000 tons) and has potential use as a winter feedstuff, but concern over the presence of the endophyte, and nutritional quality has curtailed its utilization. In addition, recent research has indicated perennial ryegrass straw also contains substantial amounts of fungal produced ergovaline. To date, most of the endophyte alkaloid research has focused on forages, seeds, and moderate-to-good quality tall fescue hays. No research has been conducted to evaluate the feeding of straw with high alkaloid concentrations and its subsequent effect on animal performance. In addition, very little is known about whether the consumption of a high-endophyte-containing straw by cattle during the winter can induce fescue toxicosis symptoms, specifically vasoconstriction of the extremities. Therefore, this research was conducted to evaluate the effect of alkaloid concentration in feeding high-endophyte-infected tall fescue straw on nutrition, physiology, and subsequent performance of beef cattle.

## Materials and Methods

**Harvesting and Treatment of Residues.** Two varieties of tall fescue straw (Bonanza and Titan turf-type) were selected to assess endophyte effects on beef cattle nutrition and performance. The two varieties were similar genetically and phenotypically, but differed in alkaloid concentrations. The Bonanza straw came from a third year stand and was baled 15 d after seed harvest. The Titan straw came from a second year stand and was baled 27 d after harvest. Both varieties were grown in the Willamette Valley of Oregon and are common varieties grown for seed crop production. Windrows were not raked before baling. Both

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**Table 1. Chemical Composition<sup>a</sup> of feeds (Exp. 1 and 2)**

Item	Titan	Bonanza	Alfalfa pellets
CP, %	6.3	5.3	19.4
ADIN <sup>b</sup> , %	9.4	11.6	5.5
NDF, %	67.4	71.1	50.5
ADF, %	44.6	49.2	34.1
IADF <sup>c</sup> , %	23.4	28.0	20.5
Ergovaline, ppb	475	0	

<sup>a</sup> Chemical composition expressed on a DM Basis.

<sup>b</sup> Expressed as a % of total nitrogen.

<sup>c</sup> IADF = indigestible acid detergent fiber.

straw varieties were stored in hay sheds until being trucked to Burns, after which bales were stored in stacks until chopping and feeding occurred. Straw was chopped every three weeks and stored in covered hay sheds. Because the two varieties of tall fescue straw differed in CP concentration (avg CP 7.1% and 4.9% for Titan and Bonanza, respectively), second cutting alfalfa (CP = 18.9%) was chopped and mixed with the Bonanza straw (16% alfalfa to 84% Bonanza tall fescue) to ensure isonitrogenous diets. Chemical analysis of the straws composited across time are listed in Table 1. Samples of each straw were analyzed by high performance liquid chromatography (HPLC) for ergovaline content. The Titan straw contained 475 ppb and 0 ppb for Bonanza.

**Experiment 1. Digestion/Physiology Study.** In early February 1992, 16 ruminally cannulated steers (avg wt = 370 kg) were used in a randomized complete block design. Steers were blocked by age and weight and, within blocks, randomly assigned to the following treatments: 1) 100 percent Titan; 2) 67 percent Titan-33 percent Bonanza; 3) 33 percent Titan-67 percent Bonanza and 4) 100 percent Bonanza. The basal diets of straw for treatments one through four, in order, contained 475, 317, 158 and 0 ppb ergovaline. Steers were given ad libitum access to the basal straw diets and supplemented with alfalfa pellets at .5 percent of BW of individual steers. This 36 d digestion study involved a 21 d adaptation period, 7 d intake period, 6 d of total fecal collections, 1 d of rumen profiles, and 1 d of

rumen evacuations, respectively. Physiological parameters were also measured weekly at 1 p.m. to determine physiological response to ergovaline: rectal temperatures; skin surface temperatures by an infrared thermometer at the tailhead (underside) and the ear (between the second and third rib); heart rates (area behind the left front elbow), and respiration rates were recorded. In addition, weekly blood samples were also collected via jugular venipuncture into vacutainer tubes for prolactin (PRL) analysis. Ambient barn temperatures were also measured during the study; minimum temperatures recorded at 7 a.m. and maximum temperatures at 5 p.m. The average minimum and maximum temperatures were 1.2°C and 11.1°C, respectively and ranged from -3.3°C to 18.9°C.

**Experiment 2. Performance Study.** Eighty-four Hereford x Angus steers (avg wt = 220 kg) were allotted into one of three weight blocks (light, medium, and heavy), and within weight blocks, randomly assigned to the same above treatments (7 steer/pen) for an 84 d performance trial. All the steers were supplemented with alfalfa pellets at .5 percent BW of the average pen weight. Pens were fed forage daily and feed refused was weighed back and subsampled weekly. Every 28 days steers were weighed after a 16 h shrink to measure weight gains and feed efficiencies. One steer on the 100 percent Titan straw died on d 46 of the performance trial. Necropsy on the steer suggested there was no relationship between the animal's death

**Table 2. Dry matter intake and total tract digestion of beef steers consuming graded levels of high endophyte tall fescue**

Item	% Titan tall fescue				SE <sup>a</sup>	Orthogonal contrasts		
	0	33	67	100		Linear	Quadratic	Cubic
DM intake, % BW								
Forage	1.7	1.5	1.6	1.7	.09	.84	.14	.85
Total	2.1	2.0	2.0	2.2	.09	.84	.14	.86
Apparent DMD, %	46.0	48.0	47.0	48.8	1.16	.19	.91	.29
NDF digestion, %	44.0	44.0	42.8	44.3	1.35	.94	.94	.52

Standard error, n = 4.

and treatment or alkaloid effects. Weight gain data 1 for this steer was omitted from the final statistical analysis.

## RESULTS AND DISCUSSION

### *Experiment 1. Digestion/Physiology Study.*

Neither forage nor total intake were affected by treatment; diet intakes averaged 6.0 kg and 7.7 kg, respectively ( $P > .10$ ). Total intakes on a percent body weight basis averaged 2.1 percent (Table 2). Apparent digestibility was similar for all four diets across treatments, ranging from 46 percent to 48.8 percent. Likewise, neutral detergent fiber (NDF) digestion did not differ among diets ( $P > .10$ ). These results indicate that alkaloid concentration did not affect the nutrition of the animal. Thus, any detrimental influences on performance or health would have to be mediated through physiological mechanisms.

*Physiological Response.* In regards to the physiological parameters, no treatment x time interaction occurred ( $P > .10$ ), so the means were averaged across time (Table 3). Heart rate, respiration rate, rectal, tail, and ear temperatures were similar across treatments ( $P > .10$ ). Thus, there was no evidence that the steers were stressed due to alkaloid concentration of the diet. If alkaloids were affecting metabolism, steers consuming higher concentrations of alkaloids would have displayed increased heart and respiration rates with, in all likelihood, lower surface body

temperatures.

Weekly prolactin (PRL) levels, however, decreased linearly across treatment means ( $P < .10$ ) as the levels of Titan increased in the diet. This observation does suggest that alkaloids were having a subclinical metabolic affect. The significance of this observation in regard to livestock health/performance is more difficult to determine. Prolactin, is a protein hormone involved in, among other metabolic functions, lactation and growth. Depressions in prolactin due the influence of alkaloids has been shown to reduce calf growth rates, as well as, milk production of the dam. In horses, reproductive problems such as retained and "tough and leathery" placentas have been reported, presumably due to depressions of prolactin and improper late gestational development. In cattle, this observation has not been substantiated.

*Experiment 2. Performance study.* Total forage intake illustrated a linear response ( $P < .10$ ), intakes increased with decreasing alkaloid levels (Table 4). However, steer weight gains and feed/gain ratios did not differ ( $P > .10$ ), averaging 14.0 kg and 16.2 kg, respectively. Since weight gains and feed efficiencies were fairly similar across treatments, the differences in intake may be attributed to palatability differences due to the presence of alfalfa hay in the Bonanza straw. No adverse health effects were seen during the performance 1 trial, although 100 percent Titan steers were consuming 2 mg/d ergovaline. These levels are



**Table 3. Physiological response of beef steers consuming graded levels of endophyte infected tall fescue straw**

Item	% Titan tall fescue				SE*	Orthogonal contrasts		
	0	33	67	100		Linear	Quadratic	Cubic
Heart rate beats/min	59.4	62.2	62.8	58.9	2.3	.93	.18	.82
Respiration Rate breaths/min	15.4	15.8	16.3	14.3	.87	.47	.22	.51
<b>Temperatures</b>								
Rectal, °C	38.5	38.6	38.4	38.5	.06	.24	.60	.13
Tail head, °C	35.8	35.8	36.1	35.3	.20	.23	.11	.16
Inner ear, °C	25.8	26.2	27.1	27.7	.91	.15	.93	.87
Weekly PRL ng/ml	15.4	18.8	6.7	5.5	5.0	.09	.66	.27

\*Pooled standard error, n = 3.

**Table 4. Performance data for beef steers consuming graded levels of endophyte infected tall fescue**

Item	% Titan tall fescue				SE*	Orthogonal contrasts		
	0	33	67	100		Linear	Quadratic	Cubic
Forage intake, kg	4.8	4.3	4.3	4.2	.18	.07	.34	.68
Total intake, kg	5.8	5.4	5.3	5.3	.08	.08	.35	.68
Weight gain, kg	14.4	13.1	12.9	14.5	.98	.98	.50	.94
Feed/gain, kg	16.0	16.0	17.8	15.0	.93	.93	.61	.61

\*Pooled standard error, n = 3.

comparable to other studies in which depressions in beef cattle performance were observed.

*Discussion.* Absence of negative effects in feeding high endophyte fescue in these studies may be due to lack of environmental stress and/or the physical composition of the straw. Both trials were conducted at average ambient maximum temperatures of 9°C in an arid environment. Thus, a lack of environmental extremes (cold temperatures) may have reduced the risks of observing vasoconstriction, which precludes the onset of

fescue foot.

Another possible explanation is that straw, with its more fibrous physical nature, has a longer retention time in the rumen and is not as highly digestible as seeds and/or forages where classical symptoms of fescue syndrome and/or reduced performance are observed. Thus, although straw may have concentrations of alkaloids similar to these feeds, decreased intake, digestion, and subsequent host animal absorption of alkaloids may be lower, reducing the risk of toxicity problems or reduced gains.