# Effect of Dietary Supplementation with Vitamin E for Lactating Dairy Cows Fed Tall Fescue Hay Infected with Endophyte[1]

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## ABSTRACT

In a replicated 2-yr study, 32 Holstein cows in midlactation were fed diets containing tall fescue hay that was free of or infected with endophyte and with or without added vitamin E in a 7-wk trial to examine the effect of vitamin E supplementation on symptoms associated with fescue toxicosis. Treatments were 1) uninfected tall fescue, 2) tall fescue infected with endophyte, 3) infected tall fescue plus 1000 IU of vitamin E/d, and 4) infected tall fescue plus 2000 IU of vitamin E/d. Feed intake, milk yield, rectal temperature, and body weight change were not significantly altered by dietary treatment. Concentration of prolactin in plasma was lower for cows fed the infected tall fescue than for those fed the uninfected tall fescue. No differences in alkaline phosphatase content of plasma were detected because of tall fescue or vitamin E treatment. Vitamin E supplementation had no effect on symptoms that were associated with fescue toxicosis in lactating dairy cows fed tall fescue hay that was infected with endophyte.
(**Key words**: tall fescue, endophyte, vitamin E, lactating dairy cows)

**Abbreviation key**: **AP** = alkaline phosphatase, **ITF** = tall fescue infected with endophyte, **Prl** = prolactin, **TF** = tall fescue (free of endophyte).

## INTRODUCTION

Tall fescue (**TF**; *Festuca arundinacea* Schreb) is a cool season bunch grass that, when consumed by cattle and horses, may cause a condition referred to as fescue toxicosis. Fescue toxicosis is characterized by reduced forage intake, BW gain, and milk yield; increased rectal temperature (9, 12); and depressed concentrations of prolactin (**Prl**) (11) and alkaline phosphatase (**AP**) in serum (2). The severity of symptoms related to fescue consumption has been associated with the presence of the endophytic fungus *Acremonium coenophialum* and its alkaloids (6, 13, 16, 18). Many treatment methods have been attempted to ameliorate the toxic effect on cattle and horses fed a forage of TF infected with endophyte (**ITF**). Dougherty et al. (4) and Lauriault et al. (14) fed cattle thiamine in an attempt to ameliorate fescue toxicosis. Boling et al. (2) supplemented ITF with phenothiazine to relieve symptoms of fescue toxicosis in beef calves. Dopaminergic drugs, which inhibit the binding of dopamine to its binding sites, have been relatively successful in restoring normal grazing patterns and Prl concentrations in serum of grazing beef cattle (3).

Zanzalari et al. (22) reported that the increased respiration rates and rectal temperatures in animals consuming ITF seemed to be related to increased activity of the mixed function oxidase and cytochrome P-450 system, which in turn could increase reactive oxygen metabolites. Cimetidine, a histimine $H_2$ receptor antagonist and an inhibitor of cytochrome P-450, reversed the effects of increased respiration rate and rectal temperature. When reactive oxygen metabolites are generated faster than they can be safely neutralized, oxidative stress can result. Dietary vitamin E and Se act as antioxidants and reduce many reproductive and health disorders of cattle (8, 17). Numerous studies (7, 10, 17, 20, 21) have examined the relationship of vitamin E and Se to mammary gland health and mastitis, which is considered another type of oxidative stress. Varney et al. (19) recently observed lactational and reproductive benefits when ITF seed was supplemented with vitamin E in the diet of pregnant rats. The purpose of this study was to determine the effect of supplemental vitamin E above requirements on the clinical symptoms associated with fescue toxicosis of lactating dairy cows.

## MATERIALS AND METHODS

Thirty-two Holstein cows (8 per treatment) in midlactation (>150 DIM) were used in a replicated

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2-yr study to examine the effect of vitamin E supplementation on signs of fescue toxicosis when TF or ITF was fed. The TF contained undetectable amounts of the endophyte and total loline alkaloids, but the ITF was infected with about 55% endophyte and contained 1150 $\mu$g/g of total N-acetyl plus N-formyllolines. Treatments were 1) TF plus 0 IU of supplemental vitamin E, 2) ITF plus 0 IU of vitamin E, 3) ITF plus 1000 IU/d of vitamin E, and 4) ITF plus 2000 IU/d of vitamin E. Vitamin E was supplemented in the concentrate as *all-rac*-$\alpha$-tocopheryl acetate (Hoffmann-LaRoche Inc., Nutley, NJ) in yr 1 and as a top-dressing in yr 2. Ten kilograms of a 21% CP concentrate were fed daily. The concentrate was composed of ground corn, distillers dried grains, soybean meal, and minerals. Selenium was supplemented to achieve an additional 0.6 ppm in the concentrate. Concentrate was fed separately at the morning (0500 h) and afternoon (1500 h) feedings before the hays were offered (110% of the consumption from the previous day). Cows were housed in a tie-stall barn except during milking and from 1100 to 1500 h when they were allowed to exercise outside in a dirt lot. Intakes of hay and concentrate and milk yield were recorded daily. Samples of hay and concentrate were collected weekly and composited at the end of the study for chemical analysis by the New York DHIA (Ithaca, NY) using accepted methods of the AOAC (1). Rectal temperatures were measured on Mondays, Wednesdays, and Fridays at about 1100 h before the cows were released to exercise. The studies were conducted July 28 to September 15, 1992 (yr 1) and June 22 to August 10, 1994 (yr 2). The studies were terminated at 7 wk and were preceded by a 1-wk preliminary period during which all cows were fed TF hay and concentrate with 0 IU of vitamin E. Blood samples (10 ml) were collected from the jugular vein during the preliminary period and at wk 3, 6, and 7 into heparinized tubes (16 × 100-mm PST tubes; Becton Dickinson and Co., Franklin Lakes, NJ) and placed on ice. Plasma was harvested and stored frozen (–20°C) for later analysis of Prl and AP. The Prl was analyzed by double-antibody assay as described by Ecterkamp et al. (5). The AP was determined using a blood analyzer (Kodak Ektachem® DT60; Eastman Kodak Co., Rochester, NY).

Feed intake, milk yield, and rectal temperature were analyzed as a split plot over time using the repeated measures analysis of SAS (15). The model included treatment, year, interaction of treatment with year, cow(interaction of treatment with year), sampling week, and interaction of treatment with

TABLE 1. Chemical analyses of hays and grains fed to lactating dairy cows.

| | Hay[1] | | Grain mix[2] | | |
|---|---|---|---|---|---|
| Component | TF | ITF | 0 IU | 1000 IU | 2000 IU |
| | (% of DM) | | | | |
| yr 1 | | | | | |
| DM, % | 91.2 | 92.1 | 90.2 | 89.7 | 89.6 |
| CP | 15.1 | 16.2 | 20.8 | 20.7 | 21.3 |
| ADF | 37.7 | 35.7 | 5.8 | 6.0 | 6.3 |
| NDF | 63.6 | 60.9 | 11.4 | 12.7 | 16.4 |
| TDN | 63.0 | 64.0 | 79.0 | 79.0 | 78.0 |
| Ca | 0.44 | 0.58 | 1.27 | 1.19 | 1.13 |
| P | 0.39 | 0.41 | 0.77 | 0.75 | 0.77 |
| Mg | 0.28 | 0.26 | 0.28 | 0.28 | 0.27 |
| K | 2.64 | 3.23 | 0.93 | 0.94 | 0.96 |
| yr 2[3] | | | | | |
| DM, % | 92.1 | 92.8 | 86.7 | | |
| CP | 13.5 | 13.9 | 20.7 | | |
| ADF | 37.2 | 35.7 | 7.8 | | |
| NDF | 65.1 | 67.6 | 15.9 | | |
| TDN | 63.0 | 60.0 | 78.0 | | |
| Ca | 0.34 | 0.34 | 1.02 | | |
| P | 0.40 | 0.40 | 0.76 | | |
| Mg | 0.21 | 0.21 | 0.26 | | |
| K | 2.46 | 2.08 | 0.90 | | |

[1]TF = Tall fescue; ITF = TF infected with endophyte.

[2]0 IU = No vitamin E supplement, 1000 IU = 1000 IU/d of supplemental vitamin E, and 2000 IU = 2000 IU/d of supplemental vitamin E.

[3]One grain mix was used for all vitamin E treatments during yr 2.

TABLE 2. Least squares means for feed intake,[1] milk yield, rectal temperature, and BW changes of cows fed tall fescue with and without added vitamin E.

| | Treatment[2] | | | | |
|---|---|---|---|---|---|
| Item | TF + 0 IU | ITF + 0 IU | ITF + 1000 IU | ITF + 2000 IU | SE |
| Forage intake, kg | 17.7 | 17.0 | 16.7 | 17.7 | 0.6 |
| Milk yield, kg/d | 18.6 | 18.5 | 17.2 | 17.5 | 1.4 |
| Rectal temperature, °C | 39.3 | 39.4 | 39.2 | 39.4 | 0.2 |
| BW Change, kg | 7 | –1 | 3 | 10 | 9 |

[1]Forage intake, as-fed basis.

[2]TF = Tall fescue; ITF = TF infected with endophyte. O IU = O IU/d of supplemental vitamin E, 1000 IU = 1000 IU/d of supplemental vitamin E, and 2000 IU = 2000 IU/d of supplemental vitamin E.

sampling week; cow(interaction of treatment with year) was used as the error term to test the effect of treatment. The Prl and AP in plasma were similarly analyzed. The model included treatment, year, interaction of treatment with year, cow(interaction of treatment with year), sampling week, and interaction of treatment with sampling week. Planned comparisons were TF versus ITF, linear effect of vitamin E in ITF diets, and 0 IU of vitamin E versus added vitamin E in ITF diets.

## RESULTS AND DISCUSSION

The chemical composition of hays and concentrates (Table 1) was similar among treatment groups. One cow was removed from the study because of severe respiratory infection, and 1 cow died; both were receiving the treatment with ITF plus 2000 IU of vitamin E, and all data from those cows were omitted.

The data were combined because there was no interaction of treatment within year. Forage intake was not altered by fescue or vitamin E treatments (Table 2). The lack of depression in forage intake of cows fed ITF differs from observations of previous studies (16, 18); cows fed ITF consumed less forage than did cows fed TF (16, 18).

Milk yields were not significantly altered by fescue or vitamin E treatments (Table 2). Previously, cows fed ITF have had lower milk yields than those fed TF (18).

Rectal temperature tended ($P = 0.10$) to exhibit an interaction of treatment within year. Cows fed ITF without vitamin E supplementation tended ($P = 0.12$) to have higher rectal temperature than did cows fed ITF plus 1000 or 2000 IU/d of vitamin E in yr 1. This trend was not observed during yr 2 or overall; no differences were detected among treatments (Table 2). Rectal temperatures were 38.9, 39.6, 39.2, and 39.1 and 39.5, 39.1, 39.3 and, 39.7 for cows fed TF plus 0 IU of vitamin E, ITF plus 0 IU of vitamin E, ITF plus 1000 IU/d of vitamin E, and ITF plus 2000 IU/d of vitamin E during yr 1 and 2, respectively.

Changes in BW were not altered significantly by fescue or vitamin E treatment (Table 2). Strahan et al. (18) observed that cows fed ITF lost more BW than did cows fed TF in a similar study.

The Prl concentration in plasma was lower in cows fed ITF than in those fed TF overall (Table 3). This finding is in agreement with previous observations (2, 18).

Neither fescue nor vitamin E treatment had any effect on plasma AP content overall (Table 3). Boling

TABLE 3. Least squares means for plasma prolactin (Prl) and alkaline phosphatase (AP) of cows fed tall fescue with and without added vitamin E.

| | Treatment[1] | | | | |
|---|---|---|---|---|---|
| Item measured | TF + 0 IU | ITF + 0 IU | ITF + 1000 IU | ITF + 2000 IU | SE |
| Plasma Prl,[2] ng/ml | 83.7 | 27.4 | 52.2 | 36.6 | 15.0 |
| Plasma AP, IU/L | 36.6 | 31.7 | 34.2 | 37.6 | 4.6 |

[1]TF = Tall fescue; ITF = TF infected with endophyte. 0 IU = 0 IU/d of supplemental vitamin E, 1000 IU = 1000 IU/d of supplemental vitamin E, and 2000 IU = 2000 IU/d of supplemental vitamin E.

[2]TF versus ITF ($P = 0.02$).

et al. (2) first observed depressed AP concentrations in serum of cattle consuming ITF. The mechanism and consequence of the depressed AP are yet unknown.

The ITF fed in this study did not appear to produce the severe symptoms of toxicity (decreased forage intake and milk yield and increased rectal temperatures relative to those for cows fed TF) that have been observed in our previous lactation studies (18). The Prl depression was the most consistent measure that indicated fescue toxicosis in this study. Orchardgrass and other grass species were infiltrating the ITF stand and might have diluted the toxicity of the ITF. However, N-acetyl and N-formylloline contents did not differ among years and would not support this hypothesis.

## CONCLUSIONS

Although results for yr 1, when vitamin E was mixed into the concentrate, suggested that vitamin E supplementation might help alleviate some symptoms of fescue toxicosis, results during yr 2, when vitamin E was added as a top-dressing, did not support that observation. However, these findings warrant further studies to determine the potential impact of vitamin E for lactating dairy cows consuming ITF.

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