Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 1314-1320

PERFORMANCE OF WEANLING RABBITS FED ENDOPHYTE-INFECTED TALL FESCUE SEED CONTAINING ERGOT ALKALOIDS

J. Tor-Agbidye,[1] B. Luick,[2] P.R. Cheeke,[2] N.M. Patton,[2] and A.M. Craig[1]

[1]College of Veterinary Medicine, [2]Rabbit Research Center
Oregon State University, Corvallis, OR 97331

Abstract

Two experiments were conducted to evaluate the performance of weanling rabbits fed diets containing various levels of endophyte free (E-) and endophyte infected (E+) seeds. The diets consisted of 0%, 20%, 40%, 60%, 80% ground and 60% whole E- fescue seeds in the first experiment and 0%, 10%, 20%, 30%, 40%, 50%, and E+ control in the second. Twenty-four and 28, four-week-old weanling rabbits were used in the first and second experiments, respectively. The results in the first experiment indicated that the tall fescue E- seeds were adequate as a feedstuff and could be incorporated into diets of rabbits at levels up to 80% without any adverse effects on performance. In the second experiment, there were no consistent effects on animal growth or feed intake attributable to the various levels of ergot alkaloids consumed. Average daily weight gain was highest from the groups fed 0% E+ and was significantly different from those that received 10%, 40%, and the control diet but was not different ($P > 0.05$) from those on 20%, 30%, and 50%. Rabbits do not seem to be an appropriate laboratory animal model for the study of tall fescue endophyte toxicity. It was concluded that tall fescue E- seeds used at levels up to 80% in diets of fryer rabbits will not adversely affect their performance with respect to average daily intake, average daily weight gain and efficiency of feed utilization.

Introduction

Tall fescue (*Festuca arundinacea Schreb*) is an important cool season grass species. Hoveland (1991) indicated that of 21 states surveyed, tall fescue was used primarily for hay and pasture, with 8.5 million cattle and 688,00 horses grazing these pastures. However, most tall fescue grown in the U.S. is Kentucky 31 (KY-31), which is infected with an endophytic fungus, *Acremonium coenophialum* (Porter et. al., 1979). Although KY-31 has many desirable agronomic characteristics, animal performance has not always been as great as would be expected based on nutritional analyses (Blaser et. al., 1986).

Specific disorders in cattle associated with toxic tall fescue include fescue foot, summer fescue toxicosis, and fat necrosis (Hemken et. al., 1984) while agalactia has been associated with horses (Heimann et. al., 1981). Hoverland (1991) estimated conservatively that cattle losses from grazing toxic tall fescue exceed $600 million per year, $353 million from reproductive losses and $255 million from decreased weight gains. Porter et. al. (1979) isolated alkaloids from KY-31 and provided some of the first evidence that the fungus was capable of producing alkaloids which are N-peptide substituted amides of lysergic acid.

There has been a great deal of recent research on the toxicological significance of the alkaloids. The present state of knowledge suggests that the pyrrolizidine alkaloids in tall fescue are not major factors in livestock fescue toxicosis. Although they are of the same chemical class as the pyrrolizidine alkaloids in many poisonous plants (eg, Tansy ragwort, *Senecio jacobea*), they lack the 1, 2 double bond which these alkaloids must have to be hepatotoxic (Cheeke and Shull, 1985). Fescue toxicosis of livestock appears to be caused primarily by ergot alkaloids. Ergovaline is the predominant ergopeptide alkaloid in E+ tall fescue and accounts for 84-97% of the total ergopeptide alkaloid fraction (Lyons et. al., 1986). Many of the effects of ergot alkaloids in causing fescue toxicosis (poor growth, rough hair coat, elevated body temperature, reduced weaning weights, milk production, and reproductive efficiency, and pronounced susceptibility to heat stress) are due to alteration in prolactin secretion (Porter et. al., 1990). This may explain many of the signs of the toxicity, such as summer fescue toxicosis in cattle and reproductive disorders in horses. Ergot alkaloids are α-adrenergic antagonists, dopamine agonists, and serotonin antagonists (Riet-Crea et. al., 1988). Porter et. al. (1990) noted that E+ fescue causes neurotransmitter imbalances in cattle with alterations in dopaminergic neurotransmitters and metabolism of prolactin (produced in the pineal gland), adversely affecting growth and reproduction (Porter et. al., 1990).

Most of the observations of fescue toxicosis have been made with cattle and horses; however, a recent study with sheep fed E+ tall fescue seed showed inhibited fiber digestion in the rumen, reduced growth and an increased sensitivity of the sheep to heat stress (Hannah et. al., 1990). Increased respiration rates and rectal temperatures as well as stimulated liver enzyme activity (mixed function oxidase) have also been reported in sheep (Zanzalari et. al., 1989). Daniels et. al. (1984) reported that rabbits given tall fescue E+ extract had reduced body weigt gains.

Although effects of fescue toxicosis on various species of animals have been reported, there are no studies that have investigated the suitability of the rabbit as a model for studying the effects of E+ tall fescue. Therefore, the objectives of this study were: 1) To investigate the suitability of rabbits as a laboratory model for studying the effects of E+ tall fescue seeds, and 2) To evaluate the use of tall fescue E- seeds as a supplement for rabbit feed and the performance of weanling rabbits fed diet containing various levels of fescue E- seeds.

Materials and Methods

Proximate composition of the major dietary ingredients was taken into consideration, and diets were formulated to the specifications for rabbit diets (NRC, 1977; Cheeke, 1987; Tor-Agbidye et. al., 1990). Tall fescue E- and E+ seeds were purchased from Smuckers Ranch, Harrisburg, Oregon. Seeds were ground using the 2mm screen Wiley mill. The crude protein (CP) and acid detergent fiber (ADF) values were 17.5% and 17.3% CP and 20.8% and 18.9% ADF for E+ and E-, respectively. Diets were formulated to contain levels of 0, 20, 40, 60, 80, and 60% whole seed (WS) for the fescue E- diets and 0, 10, 20, 30, 40, and 50% endophyte infected fescue seeds for the E+ diets. Ergovaline levels in the E+ diets were quantitated using a modified assay of Rottinghaus HPLC extraction (Rottinghaus et. al., 1991) by Oregon State University (OSU) College of Veterinary Medicine Laboratory. The E+ seed contained 4.4 ppm ergovaline.

Twenty-four, four-week-old New Zealand White rabbits of both sexes were weighed and randomly assigned to the six dietary treatments, with 4 rabbits per treatment (Experiment 1). The animals were housed in a conventional rabbit facility at the OSU Rabbit Research Center. Each animal was placed in an individual cage measuring 12" x 30" x 18." Each cage was equipped with an automatic watering device and "J" type galvanized metal feeder with a screen bottom. Feed and water were available *ad libitum*. Feed consumption and weight gains were recorded weekly during the 35-day experimental period. Twenty-eight, four-week-old New Zealand White fryer rabbits were used in Experiment 2. The experimental design and procedures were similar to Experiment 1. Animals in Experiment 2 were also closely watched twice a day for any apparent clinical signs.

At the end of the experimental period the final body weight gain of each animal and feed intake were recorded. The results were used to calculate weight gain, daily feed intake, and feed efficiency. The data was subjected to a one-way analysis of variance and analyzed by GLM procedure of SAS (SAS Institute, 1991). Upon detection of differences, the means were separated by Duncan's method of means comparison.

Results and Discussion

Performance of the weanling rabbits fed tall fescue E- seeds from Experiment 1 is shown in Table 2. The lowest average daily feed intake was for the group of animals on the diet containing 80% fescue seeds, and this was significantly different ($P < 0.05$) from the control diet. Although there was no significant difference in feed intake ($P > 0.05$) among all levels of fescue seed, the daily feed intake tended to decrease as dietary seed level increased.

The average daily weight gain (ADG) values ranged from 41.10 ± 2.12 for the group with diet containing 80% fescue, to 45.34 ± 2.15 for the group on 60% fescue, but were not different ($P > 0.05$) between treatments. Also, the feed efficiency ratio was not significantly different ($P > 0.05$). The group fed the control diet had the highest feed intake (130.4 ± 6.4 g/day). This reflects the higher fiber level due to the higher level (40%) of alfalfa meal in the control diet. It was also observed that grinding of the fescue seeds did not affect the performance of the rabbits, indicating that the mastication and digestive processes in the rabbit can break down intact grass seeds.

The fescue seed that was used in this study was also fed to lambs at dietary ergovaline levels varying from 150 ppb to 2000 ppb (Cheeke, unpublished observations). All levels of dietary ergovaline reduced feed intake and growth rate of lambs, with a linear reduction in performance as ergovaline level increased. The lack of effect of dietary ergovaline with rabbits indicates that they are much more tolerant to ergot alkaloids than sheep fed the same seed as a source of alkaloid. This would indicate that rabbits are probably not a good model for studies of tall fescue toxicosis. On the other hand, the results indicate that grass seed screenings are well utilized by rabbits, and in localized areas where grass seed is produced, such as western Oregon, by-products of the grass seed industry could be utilized in rabbit feeding.

Acknowledgement

Funding for this project was provided by the Oregon Tall Fescue Commission. Their support is gratefully acknowledged.

References

Aldrich, C.G., M.T. Rhodes, J.L. Miner, J.A. Paterson and M.S. Kerley. 1990. Effects of consumption of tall fescue infected with endophytic fungus and supplementation with dopamine antagonist on heat dissipation, body temperature and blood flow parameters in ruminants housed at elevated temperatures. In: Proceedings International Symposium on Acremonium/Grass Interactions. S.S. Quisenberry and R.E. Joost Ed. p. 205.

Blaser, R.E., R.C. Hammes, H.T. Bryant, C.M. Kincaid, W.H. Skrdla, T.H. Taylor and W.L. Griffeth. 1986. The value of forage species and mixtures for fattening steers, Agron. J. 48:508.

Cheeke, P.R. 1987 Rabbit Feeding and Nutrition. Academic Press, Orlando, Fl.

Cheeke, R.P. and L.R. Shull. 1985. Natural Toxicants in Feeds and Poisonous Plants. AVI Publ. Co., Westport, CT.

Cheeke, P.R. 1992 (Unpublished personal communication).

Daniels, L.B., A. Ahmed, T.S. Nelson, E.L. Piper and J.N. Beasley. Physiological responses in pregnant white rabbits given a chemical extract of toxic tall fescue. Nutr. Rep. Int. 29:505.

Hannah, S.M. J.A. Paterson, J.E. Williams, M.S. Kerley and J.L. Miner. 1990. Effect of increasing dietary levels of endophyte-infected tall fescue seed on diet digestibility and ruminal kinetics in sheep. J. Anim. Sci. 68:1693.

Heimann, E.D., L.W. Garret, W.E. Loch, J.S. Morris, W.H. Pfander. 1982. Selenium and reproductive abnormalities in pregnant pony mares grazing fescue pastures. Proceedings, 7th Equine Nutrition Physiology Symposium. p. 62.

Hempken, R.W., J.A. Jackson and J.A. Boling. 1984. Toxic factors in tall fescue. J. Anim. Sci. 58:1011.

Hoveland, C.S. 1990. Survey reveals heavy losses from toxic tall fescue. Hay and Forage Growers. 6:1:28.

Lyons, P.C., R.D. Plattner and C.W. Bacon. 1986. Occurrence of peptide and clavine ergot alkaloids in tall fescue grass. Science 232:487.

National Research Council. 1977. Nutrient requirements of domestic animals. Nutrient requirements for rabbits, NAS, Washington, D.C.

Porter, J.K. C.W. Bacon and J.D. Robbins. 1979. Ergosine, ergosine and chanoclavinel from Epichole typhina. J. Agric. Food Chem. 27:595.

Porter, J.K., J.A. Stuedemann, F.N. Thompson, Jr. and L.B. Lipham. 1990. Neuroendocrine measurements in steers grazed on endophyte-infected fescue. J. Anim. Sci. 68:3285.

Riet-Correa, J., M.C. Mendez, A.L. Schild, P.N. Bergamo and W.N. Flores. 1988. Agalactia, reproductive problems and neonatal mortality in horses associated with the ingestion of Claviceps purpurea. Aust. Vet. J. 65:192.

Rottinghaus, G.E., G.B. Garner, C.N. Cornell and J.L. Ellis. 1991. HPLC method for quantitating ergovaline in endophyte-infested tall fescue: Seasonal variation of ergovaline levels in stems with leaf sheaths, leaf blades and seed heads. J. Agric. Food Chem. 39:112.

Tor-Agbidye, Y., K.L. Robinson, P.R. Cheeke, R.S. Karow and N.M. Patton. 1990. Nutritional evaluation of buckwheat (Fagopyrum esculentum) in diets of weanling rabbits. J. Appl. Rabbit Res. 13: 210.

Zanzalari, K.P., R.N. Heitmann, J.B. Mclaren and H.A. Fribourg. 1989. Effects of endophyte-infected fescue and cimetidine on respiration rates, rectal temperatures and hepatic mix function oxidase activity as measured by hepatic antipyrine metabolism in sheep. J. Anim. Sci. 67:3370.

Table 1. Percentage composition of experimental diets.

	% Fescue Seeds					
Ingredients	0	20	40	60	80	60WS*
Alfalfa	40.00	30.50	21.00	11.50	2.00	11.50
Wheat mill run	21.00	16.00	11.00	6.00	1.00	6.00
Corn	22.00	16.50	11.00	5.50	0.00	5.50
Soybean meal	11.50	11.50	40.00	11.50	11.50	11.50
Fescue seed	0.00	40.00	60.00	60.00	80.00	60.00
Molasses	3.00	3.00	3.00	3.00	3.00	3.00
Dicalcium phosphate	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral salts	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25
Vegetable oil	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	0.50	0.50	0.50	0.50	0.50	0.50

* 60% whole seed.

Table 2. Performance of weanling rabbits fed endophyte free (E- tall fescue seeds.

Diets	Initial Wt. (g)	Net Gain (g)	ADG (g)	ADFI (g)	Feed/ Gain
Control	750.75 ± 149.36^{NS}	1550.75 ± 34.22^{NS}	44.31 ± 0.98^{NS}	130.44 ± 6.39^{a}	2.95 ± 0.17^{NS}
20% Fescue	672.50 ± 156.27	1541.25 ± 111.39	44.04 ± 3.19	121.39 ± 8.48^{ab}	2.77 ± 0.11
40% Fescue	741.25 ± 135.82	1465.75 ± 95.57	41.88 ± 2.73	120.15 ± 8.52^{ab}	2.77 ± 0.17
60% Fescue	775.00 ± 156.53	1587.00 ± 75.24	45.34 ± 2.15	119.87 ± 9.09^{ab}	2.65 ± 0.20
80% Fescue	760.25 ± 138.51	1438.50 ± 74.32	41.10 ± 2.12	107.52 ± 7.32^{b}	2.63 ± 0.20
60% WS Fescue	751.25 ± 145.24	1501.00 ± 98.91	42.89 ± 2.83	121.51 ± 11.33^{ab}	2.83 ± 0.15

a differs from b ($P<0.05$).

Table 3. Performance of weanling rabbits fed endophyte infected (E+) tall fescue seeds.

Diets	Initial Wt (g)	Net Gain (g)	ADG (g)	ADFI (g)	Feed/Gain	Diet Ergovaline (ppb)	Daily Ergovaline Intake (μg)
0% E+ seeds	863.00 ± 40.36^{NS}	1703.33 ± 36.19^{a}	48.67 ± 1.03^{a}	83.75 ± 3.81^{ab}	1.72 ± 0.64^{b}	0.0	00.00
10% E+ seeds	855.00 ± 41.00	1125.00 ± 161.78^{c}	32.15 ± 4.62^{c}	84.12 ± 2.08^{ab}	2.77 ± 0.37^{a}	440.00	37.02
20% E+ seeds	913.25 ± 28.25	1449.25 ± 108.82^{ab}	41.41 ± 3.12^{ab}	98.74 ± 7.55^{a}	2.42 ± 0.23^{a}	860.00	84.92
30% E+ seeds	888.25 ± 44.83	1474.50 ± 60.89^{ab}	42.13 ± 1.74^{ab}	90.72 ± 4.85^{ab}	2.16 ± 0.10^{ab}	1320.00	119.75
40% E+ seeds	863.50 ± 31.50	1324.75 ± 16.14^{bc}	37.85 ± 1.89^{bc}	81.96 ± 4.15^{b}	2.18 ± 0.16^{ab}	1720.00	140.97
50% E+ seeds	871.75 ± 84.89	1441.25 ± 66.85^{ab}	41.18 ± 1.19^{ab}	91.58 ± 3.47^{ab}	2.24 ± 0.12^{ab}	2250.00	206.06
OSU #64 Control	879.50 ± 47.46	1292.00 ± 83.93^{bc}	36.92 ± 2.40^{bc}	86.31 ± 2.67^{ab}	2.36 ± 0.08^{a}	0.00	0.00

[abc] Means within the same column with different superscripts differ significantly ($P<0.05$).