Effect of Feeding Endophyte-Infected Feed and Bedding on the Performance of Broilers

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Primary Audience: Broiler Producers, Flock Supervisors, Researchers

SUMMARY

Two varieties of chopped grass seed straw, tall fescue (*Festuca arundinaces* L.) and perennial ryegrass (*Lolium perenne* L.), were identified as alternative sources to wood sawdust or shavings as bedding for use by Pacific Northwest broiler producers. However, some broiler growers expressed concern that straw may be contaminated with endophytes, symbiotic fungi that are known to be toxic to livestock. The primary toxic compound of concern for livestock in endophyte infected grass straw is ergovaline.

Two experiments were conducted to determine if broiler performance was affected by either the feeding of endophyte infected grass seed containing ergovaline, or rearing broilers on endophyte infected grass seed straw. The exposure of broilers to either endophyte-infected chopped straw as bedding and/or feeding endophyte infected ground grass seed in the diet with ergovaline levels as high as 423 ppb, did not significantly affect performance or the micro anatomy of kidney or liver tissues.

Key words: broiler performance, endophyte, ergovaline

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DESCRIPTION OF PROBLEM

Alternative broiler litter sources have been of interest to broiler producers in the Pacific Northwest because of escalated costs and the short supply of wood shavings and sawdust due to use in other value-added products. These contributing factors provided impetus to search for alternative litter sources. Additionally, an abundance of a promising alternative, grass seed straw, in excess of one million metric tons annually is available to northwestern broiler producers at a much-reduced cost compared with wood shavings or sawdust.

Various types of cereal straw have been evaluated as broiler bedding in the past with mixed success [1]. Two varieties of chopped grass seed straw, tall fescue (*Festuca arundinaces* L.) and perennial ryegrass (*Lolium perenne* L.), were identified as alternatives to wood sawdust or shavings as bedding litter for commercial broiler production for producers in the Northwest [2, 3]. However, some broiler growers have expressed concern about the use of straw in their production units that may be contaminated with endophytes.

Endophytes are a group of symbiotic fungi that are found in some grasses. These fungi pro-

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TABLE 1. Composition of the diets used in experiment 1

Ingredient	Ergovaline (ppb)				
	0	25	50	100	400
	%				
Ground corn	17.00	17.00	17.00	17.00	17.00
SBOM (47.5% CP)	33.37	33.37	33.37	33.37	33.37
Meat and bone meal	7.54	7.54	7.54	7.54	7.54
Poultry blend fat	15.00	15.00	15.00	15.00	15.00
Ground limestone	0.59	0.59	0.59	0.59	0.59
Salt[A]	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.20	0.20	0.20	0.20	0.20
Vitamin premix[B]	0.20	0.20	0.20	0.20	0.20
Mineral premix[C]	0.05	0.05	0.05	0.05	0.05
Solka-floc[D]	25.80	24.19	22.58	19.35	0.00
Ground fescue seed[E]	0.00	1.61	3.22	6.45	25.80
Analyzed level					
Ergovaline (ppb)	0	25	45	91	423
Crude protein (%)	21.7	21.6	22.0	21.5	23.2

[A]Iodized salt.
[B]Provided per kilogram of diet: retinyl acetate, 7,480 IU; cholecalciferol, 3,300 IU; DL-α-tocopheryl acetate, 20 IU; menadione bisulfate complex, 2.2 mg; thiamine 4.4 mg; vitamin B_{12}, 16 μg; riboflavin, 5.5 mg; biotin, 0.22 mg; pantothenic acid, 11 mg; pyridoxine 3.6 mg; niacin, 44 mg; choline chloride, 1.2 g; folic acid, 1.1 mg; and ethoxyquin, 313 mg.
[C]Provided per kilogram of diet: manganese, 77 mg; iron, 77 mg; copper, 8.8 mg; zinc, 66 mg; and selenium, 0.33 mg.
[D]International Fiber Corporation, North Tonawanda, NY.
[E]Ground fescue seed was analyzed to contain 1,550 ppb of ergovaline.

duce alkaloids that cause clinical signs of disease when fed to some livestock, particularly cattle and horses [4, 5, 6, 7]. Clinical signs of ergovaline toxicosis in cattle can have been noted when concentrations of ergovaline in grass forages are as low as 50 ppb [8]. The most important fungi in this group is *Neotyphodium coenophialum*, which produces several toxic compounds with ergovaline being of the most concern. Ergovaline concentrations in tall fescue and perennial rye grass seed and forage have been quantified at levels between 2 and 6 ppm and 5 ppm, respectively [9].

Because there is a paucity of information on the effect of endophyte-infected grass seed and grass straw bedding on broiler performance, these studies were conducted to determine the effect on broiler performance and kidney and liver histologies when broilers were fed various levels of ergovaline in the diet, or broilers were housed with ergovaline-infected chopped grass seed straw as bedding.

Experimental Procedure

Experiment 1. One hundred sixty (80 males and 80 females) commercial broiler chicks (Peterson × Arbor Acres) were fed various levels of endophyte-infected fescue seed (*Festuca arundinaces* L.) from d 1 to 3 wk of age. The seed, which was analyzed to contain 1,550 ppb ergovaline, was ground and mixed with corn-soy mash feed at 0 (control), 1.61, 3.22, 6.45, and 25.8% to provide diets containing 0 (control), 25, 45, 91, or 423 parts per billion (ppb) ergovaline, respectively (Table 1). Each diet was fed to 4 replicate groups of 8 chicks (4 males and 4 females) with a total of 32 chicks per treatment. The chicks were reared in a battery brooder on raised wire floors with supplemental heat and light. The feed was weighed for each replicate group at the beginning and conclusion of the experiment to determine feed consumption. Feed and water were provided ad libitum. Mortality was recorded daily. At 3 wk of age, all of broilers were individually weighed.

The ergovaline content of the seed was analyzed by HPLC by the Oregon State University Veterinary Diagnostic Laboratory [10], and crude protein levels in each diet were determined by Kjeldahl analysis. At the conclusion of the experiment, 1 male and 1 female broiler were randomly selected from each dosage group and

TABLE 2. Composition of the basal diets used in experiment 2

Ingredient	Starter (%)			Finisher (%)		
	Fescue (Fawn)	Fescue (SR8300)	Rye (NUI)	Fescue (Fawn)	Fescue (SR8300)	Rye (NUI)
Corn	61.82	61.82	61.82	63.72	63.72	63.72
SBOM 47.5%	27.25	27.25	27.25	28.75	28.75	28.75
Meat and bone meal	6.00	6.00	6.00	—	—	—
Poultry blend fat	3.10	3.10	3.10	3.90	3.90	3.90
Ground limestone	1.00	1.00	1.00	1.72	1.72	1.72
Biophos[A]	0.33	0.33	0.33	1.36	1.36	1.36
Salt[B]	0.25	0.25	0.25	0.35	0.35	0.35
DL-Methionine	0.10	0.10	0.10	0.05	0.05	0.05
Vitamin premix[C]	0.05	0.05	0.05	0.05	0.05	0.05
Trace mineral premix[D]	0.05	0.05	0.05	0.05	0.05	0.05
Amprolium, 25%	0.05	0.05	0.05	0.05	0.05	0.05
Total	100.0	100.0	100.0	100.0	100.0	100.0
Analyzed crude protein (%)	21.7	21.7	21.7	22.0	22.0	22.0
Grass seed additions to the formulated diet[E]						
Ground fescue (Fawn)[F]	2.7	0.87	—	2.7	0.87	—
Ground fescue (SR8300)[G]	—	1.83	—	—	1.83	—
Ground rye (NUI)[H]	—	—	2.7	—	—	2.7
Calculated ergovaline (ppb)	0	50	50	0	50	50
Analyzed ergovaline (ppb)	<10	68	54	14	61	50

[A]Hoodridge International, Parkland, FL.
[B]Iodized salt.
[C]Provided per kilogram of diet: retinyl acetate, 7,480 IU; cholecalciferol, 3,300 IU; DL-α-tocopheryl acetate, 20 IU; menadione bisulfate complex, 2.2 mg; thiamine, 4.4 mg; vitamin B_{12}, 16 μg; riboflavin, 5.5 mg; biotin, 0.22 mg; pantothenic acid, 11 mg; pyridoxine 3.6 mg; niacin, 44 mg; choline chloride, 1.2 g; folic acid, 1.1 mg; and ethoxyquine, 313 mg.
[D]Provided per kilogram of diet: manganese, 77 mg; iron, 77 mg; copper, 8.8 mg; zinc, 66 mg; and selenium, 0.33 mg.
[E]Ground grass seed was added to the prepared basal diet.
[F]Analyzed ergovaline level of 0 ppb.
[G]Analyzed ergovaline level of 1,862 ppb.
[H]Analyzed ergovaline level of 2,726 ppb.

euthanized, and liver and kidney tissues were excised. The tissue samples were immediately placed in 10% neutral, buffered formalin for subsequent histopathological analyses after hematoxylin and eosin staining.

Experiment 2. Two thousand eight hundred straight-run broiler chicks (Peterson × Arbor Acres) were reared on chopped tall fescue or perennial ryegrass seed straw bedding that was endophyte free or endophyte infected. Mash feeds were formulated to contain 0 or approximately 50 ppm ergovaline by mixing 2.7% ground fescue (SR8300) or a mixture of 1.83% ground fescue (NUI) and 0.87% perennial ryegrass (Fawn) seed with a basal corn-soy diet (Table 2). Addition of the 2.7% ground fescue seed (Fawn), which contained no ergovaline, served as the control (Tables 2 and 3). Descriptions of the experimental treatments are given in Table 3. Each treatment was replicated in 4 pens of 100 broilers each. Broilers exposed to the endophyte-free seed and straw served as the control group. The chopped straw bedding was spread 5 to 10 cm deep on concrete floor pens that measured 3.25 × 4.06 m. Each pen had 2 supplemental heat lamps and 2 bell drinkers. Feed was provided ad libitum in hanging tube feeders.

The ground endophyte-free and -infected grass seed, the resulting mixed feeds, and the chopped grass seed straw samples used for bedding were analyzed for ergovaline content [10]. At 7 wk of age, males and females from each pen were weighed separately. Feed consumption for each replicate pen was determined at the conclusion of the experiment. Daily mortality was recorded throughout the experiment. After being weighed, 1 male and 1 female were ran-

TABLE 3. Experimental treatments (experiment 2)

Treatment	Treatment description	Endophyte-free (fawn fescue)		Endophyte-infected tall fescue (SR8300)		Endophyte-infected perennial rye (NUI)	
		Bedding[A]	Feed[B]	Bedding	Feed	Bedding	Feed
1	Endophyte-free fescue seed and bedding	X[C]	X				
2	Endophyte-free fescue feed, infected fescue bedding			X			
3	Endophyte-free fescue feed, infected rye bedding		X			X	
4	Endophyte-infected fescue feed, free fescue bedding	X			X		
5	Endophyte-infected rye feed, endophyte-free fescue bedding	X					X
6	Endophyte-infected fescue feed, infected fescue bedding			X	X		
7	Endophyte-infected rye feed, infected rye bedding					X	X

[A]Straw was chopped in 5- to 10-cm lengths and placed on the floor of each pen at 5 to 10 cm deep.
[B]All seed samples were ground and added to mixed corn-soy feeds to attain 0 or 50 ppb ergovaline.
[C]X = indicates treatments applied.

TABLE 4. Effect of feeding varied levels of ergovaline in ground endophyte-infected tall fescue seeds to broiler chicks from 1 d to 3 wk of age on broiler performance (experiment 1)

Dietary ergovaline (ppb)	Mean body weight (g)[A]			Feed conversion[B]	Mortality (died per total)
	Males[C] (n = 8)	Females[C] (n = 8)	M + F		
0	617 ± 12[a]	544 ± 23[a]	574 ± 19[a]	1.95 ± 0.06[b]	0/32
25	602 ± 12[a]	570 ± 16[a]	590 ± 12[a]	1.77 ± 0.09[b]	2/32
45	638 ± 11[a]	585 ± 19[a]	613 ± 9[a]	1.70 ± 0.02[b]	0/32
91	645 ± 20[a]	582 ± 9[a]	615 ± 7[a]	1.78 ± 0.05[b]	0/32
423	784 ± 14[b]	722 ± 68[b]	762 ± 13[b]	1.52 ± 0.07[a]	0/32

[a,b]Mean values within each column with different superscripts are significantly different at $P < 0.05$.
[A]Weight ± SE.
[B]Feed consumed per body weight.
[C]Number of broilers at placement.

domly selected from each replicate group and euthanized, and liver and kidney tissues were excised and immediately placed in 10% neutral buffered formalin solution for histolopathologic examination after hematoxylin and eosin staining.

Body weight, feed consumption, and mortality data were analyzed for statistical differences by one-way analysis of variance [11], and differences between means were determined by least significant differences test ($P < 0.05$).

RESULTS AND DISCUSSION

Experiment 1

The performance data for experiment 1 are presented in Table 4. No significant differences ($P < 0.05$) in body weight were observed between the broilers fed endophyte-free and -infected fescue seeds containing 0, 25, 45, or 91 ppb of ergovaline for males, females, or combined sexes. With 423 ppb ergovaline, broilers were significantly ($P < 0.05$) heavier than those

TABLE 5. Effect of endophyte-free straw and seeds and endophyte-infected tall fescue and perennial ryegrass straw and seeds on broiler performance of birds reared under simulated industry growing conditions from 1 d to 7 wk of age (experiment 2)

Treatment	Mean body weight (kg)[A]			Feed conversion[B]	Mortality (%)
	Males	Females	Male + female		
1	2.27 ± 0.04[a] (n = 203)[C]	1.88 ± 0.02[a] (n = 196)[C]	2.07 ± 0.03[a]	2.08 ± 0.07[a]	2.00 ± 0.01[a]
2	2.36 ± 0.04[a] (n = 200)	1.95 ± 0.02[a] (n = 191)	2.16 ± 0.06[a]	2.13 ± 0.07[a]	1.75 ± 0.01[a]
3	2.35 ± 0.03[a] (n = 187)	1.98 ± 0.02[a] (n = 204)	2.16 ± 0.01[a]	2.07 ± 0.14[a]	2.75 ± 0.01[a]
4	2.26 ± 0.05[a] (n = 184)	1.87 ± 0.11[a] (n = 197)	2.07 ± 0.06[a]	2.19 ± 0.03[a]	1.25 ± 0.01[a]
5	2.25 ± 0.06[a] (n = 195)	1.87 ± 0.03[a] (n = 186)	2.06 ± 0.08[a]	2.18 ± 0.10[a]	1.25 ± 0.01[a]
6	2.35 ± 0.04[a] (n = 203)	1.89 ± 0.04[a] (n = 203)	2.12 ± 0.06[a]	2.18 ± 0.80[a]	2.50 ± 0.01[a]
7	2.26 ± 0.04[a] (n = 203)	1.99 ± 0.06[a] (n = 203)	2.13 ± 0.04[a]	2.19 ± 0.12[a]	2.25 ± 0.01[a]

[a]Mean values within each column with different superscripts are significant at $P \leq 0.05$.
[A]Body weight ± SE.
[B]Feed consumed per body weight.
[C]Variations in bird numbers at the conclusion of the experiment is partially due to variations in box chick numbers at placement.

fed feeds containing 0, 45, 50, or 91 ppb ergovaline from endophyte-infected seed. Feed conversion was also significantly ($P < 0.05$) better in chicks fed the highest level of ergovaline. The difference in mean body weights between the lower ergovaline levels (0, 25, 41, and 91 ppb) and the higher ergovaline level (423 ppb) may be attributed to the higher protein in the diet as a result of the high level (25.8%) of added ground fescue seed. The level of ergovaline in the diet did not influence mortality (Table 4).

Histopathological examinations of liver and kidney tissues indicated no gross or microscopic abnormalities. Under the conditions of this experiment, broilers fed feeds containing ergovaline levels as high as 423 ppb from endophyte-infected grass seed showed no adverse effect on growth or feed consumption or in the histologies of the liver or kidney.

Experiment 2

Performance data for experiment 2 are presented in Table 5. Broilers housed on endophyte-infected straw and fed approximately 50 ppb of ergovaline from the addition of endophyte-infected fescue or perennial rye grass seed showed no significant differences ($P < 0.05$) in mean body weights of males, females, or combined sexes, feed conversion or mortality among treatments. Histopathological examinations of the liver and kidney tissues showed no indication of any changes at the cellular level.

CONCLUSIONS AND APPLICATIONS

1. Broiler performance was not adversely affected by ergovaline levels as high as 423 ppb in feed.
2. High levels (423 ppb) of ergovaline in the diets of broiler chickens did not cause damage to liver or kidney tissue.
3. High levels of ergovaline in grass seed straw used for broiler bedding did not affect performance.
4. Endophyte-infected chopped grass seed straw can be used as broiler bedding without affecting performance.

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