Nutritional Quality of Grass Seed Residues Harvested for Livestock Feed in Western Oregon

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SUMMARY: A survey of nearly 300 fields of grass seed straw was conducted to address questions regarding the nutritional quality of grass seed residues. Based on this survey, bentgrass, perennial ryegrass and tall fescue had chemical compositions that indicate higher nutritional quality compared to orchardgrass and annual ryegrass. Bentgrass had favorable crude protein and fiber characteristics despite reaching maturity late in the season and higher rainfall. Orchardgrass and annual ryegrass displayed lower crude protein and higher fiber content, which would limit intake and digestibility of these straws when used as a livestock feedstuff.

The potential use of grass seed residues as a alternative winter feedstuff is not a new concept, however, currently only a small fraction of these crop residues are used as a domestic livestock feed. The lack of information and/or industry knowledge regarding the nutritive quality of residues is a primary factor limiting its use as a livestock feed resource. Dramatic changes, however, are occuring in the grass seed and beef cattle industry that may integrate these industries in regard to grass seed residues.

In the grass seed industry, air pollution concerns dictate a search for alternative methods of sanitization of grass fields and disposal of straw residue. Likewise, in the beef cattle industry, large amounts of capital, as well as, meadow acreages are devoted to the production of hays for feeding cattle during the winter months. Additionally, concern over the use of public rangelands may force the beef cattle industry to rely more solely on private rangelands and hay meadows in the near future. Therefore, the increased use of grass seed residues as a livestock feed resource may provide solutions to problems plaguing two of Oregon's most important agricultural industries.

The objectives of the following study were to survey Willamette Valley grass seed residues for 1) nutritional quality, 2) harvesting factors that may influence nutritional quality, and 3) the presence of antiquality factors (ergovaline) in tall fescue and perennial ryegrass residues.

MATERIALS & METHODS

In mid-April of 1991, the Agricultural Fiber Association, an organization composed of baling contractors and grass seed growers, was consulted to obtain a group of baling cooperators who would be willing to participate in the summer sampling of grass seed straws. The twelve baling contractors who agreed to participate were based in both the north and south ends of the Willamette Valley. Each day between 6 a.m. to 7 a.m., during the months of July to mid September, these baling contractors were contacted by telephone to receive daily field baling locations that encompassed a seven county area (Clackamas, Benton, Polk, Linn, Lane, Marion, and Yamhill counties). Grass species sampled included tall fescue (*Festuca arundinacea* Shreb.), orchardgrass (*Dactylis glomerata* L.), perennial ryegrass (*Lolium perenne* L.), annual ryegrass (*Lolium multiforum*), and bentgrass (*Agrostis* L.). Perennial ryegrass composed 46.3 percent of the total samples (136 samples), followed by tall fescue at 41.5 percent (122 samples), bentgrass at 8.8 percent (26 samples) and all other grasses at 3.4 percent (Table 1). Bales were sampled randomly from either stacks or individual bales throughout the field. Enough straw was removed to provide 150 g of sample when ground through a 1 mm Wiley Mill screen (10 to 20 cores per sample). Samples were given identification numbers, identifying the sample by grass species and variety, seed producer, baling contractor, and field location. After the completion of the grass seed harvest, letters and questionnaires were sent to seed producers to obtain background information on the seed field.

RESULTS & DISCUSSION

Background Information. Orchardgrass and

annual ryegrass had the earliest harvest dates for the species sampled, followed by tall fescue, perennial ryegrass, and bentgrass (Table 1) during the 1991 baling season. Annual ryegrass had the shortest time length from swathing to baling, followed by orchardgrass, bentgrass, tall fescue, and perennial ryegrass. In terms of precipitation, bentgrass residues were exposed to the highest levels due to rainfall occurring in late August and early September, during the time this grass species was harvested. Annual ryegrass, was exposed to the lowest amount of precipitation, followed by orchardgrass, perennial ryegrass and tall fescue.

This information was gathered to assist prospective cattle producers who would consider buying straw as a winter livestock feed. These variables can be used as general guidelines in purchasing straw. Knowledge about precipitation is very important, since it can have a large impact on the nutritional quality of straw. In addition, knowledge about when certain grass species reach maturity, and how long until they are baled, can help a producer in planning when to buy a specific species of straw, as well as make transportation and storage arrangements ahead of the time of purchase.

Crude Protein. The range of 6 to 8 percent crude protein (CP) has become a common standard from which to gauge the need for protein supplementation when feeding a particular feedstuff. In this survey, tall fescue, bentgrass, and perennial ryegrass had higher mean CP levels as compared to orchardgrass and annual ryegrass (Table 1). However, these feeds are all deficient in protein and will require some form of protein supplementation.

Traditionally, grass seed straws were put in the same class as cereal grain straws as having low CP levels. In actuality, these levels are higher in comparison to cereal grain straws, which range from 2 to 4 percent CP. Although grass seed straws have higher protein levels, these straws do require some form of protein supplementation, but the amount is relatively small as compared to that required for feeding cereal grain straws. The primary reason most grass seed straws have a higher protein level, as compared to cereal grain straws, is due to a greater leaf content in grass seed straws. Greater leaf to stem ratios are due, in part, to the fact that most grass seed species are perennial crops, whereas cereal grains are annual crops. Stems are often of a lower quality than leaves in mature forage due to increases in lignified structures in stems as compared to leaves.

Acid Detergent Insoluble Nitrogen. Acid detergent insoluble nitrogen (ADIN) gives an indication of the amount of unavailable nitrogen in a particular feedstuff. It yields mainly lignified nitrogen or the amount of nitrogen (CP) that is unavailable for ruminant digestion. Grass seed straws in this survey had low levels of ADIN, even though straw is a highly lignified feedstuff. Tall fescue had the lowest mean ADIN levels, with perennial ryegrass, annual ryegrass, and bentgrass being intermediate, and orchardgrass having the highest levels of ADIN ($P<.05$) (Table 4). Acid detergent insoluble nitrogen levels are expressed as a percentage of the total nitrogen in a sample. A higher percentage of the protein in these straws is available for microbial digestion. In addition, the ADIN levels reported in grass straws are comparable to low quality meadow or grass hays.

Fiber Constituents: Neutral Detergent Fiber and Acid Detergent Fiber. Bentgrass, perennial ryegrass, and tall fescue had similar neutral detergent fiber (NDF) levels as compared to orchardgrass and annual ryegrass ($P<.05$) (Table 5). Neutral detergent fiber measures plant cell wall constituents, such as cellulose, hemicellulose, and lignin, which are partially digestible due to microbial breakdown. Plant cell wall constituents are the primary determinant of intake potential.

Acid detergent fiber (ADF) components mirrored NDF. Bentgrass had a lower percentage ADF as compared to the other four species, with orchardgrass and annual ryegrass having the highest ADF levels ($P<.05$) (Table 1). Acid detergent fiber analysis digests the hemicellulose and cell wall proteins, leaving the cellulose, lignin, and lignified nitrogen as a residue. This analysis indicates the relative digestibility of forages, with higher ADF levels being correlated to lower digestibility.

In vitro dry matter digestibility. In vitro dry matter digestibility measures the availability of feed to rumen bacteria or animal digestive

Table 1. Nutritional Quality and Harvest Conditions for Willamette Valley Grass Seed Residues[a]

Item	Bentgrass	Perennial Ryegrass	Tall Fesue	Annual Ryegrass	Orchardgrass
Fields Sampled	26	136	122	5	5
Harvest Factors:					
Harvest Date	Aug. 4	Jul. 22	Jul. 12	Jul. 8	
Swath to Baling	19.9	23.3	20.7	9.5	11.5
Precipitation	1.2	.6	.7	.5	
Crude Protein:					
Range	3.9-7.0	3.6-9.4	3.7-8.9	4.3-5.2	3.7-5.7
Mean	5.4	5.3	5.6	4.7	4.8
SD	.91	.88	.90	.35	.95
ADIN:					
Range	13.1-25.3	5.1-23.0	7.3-20.7	12.6-22.8	15.6-21.4
Mean	16.6	15.5	12.8	16.4	
SD	2.69	3.03	2.63	4.17	
NDF:					
Range	56.6-76.3	60.5-74.2	62.1-76.6	65.3-80.5	64.3-70.6
Mean	63.7	65.8	67.9	72.8	68.2
SD	3.71	2.79	3.19	6.97	2.75
ADF:					
Range	34.1-40.8	37.9-49.0	39.9-52.9	41.8-52.0	46.2-49.9
Mean	37.9	41.6	43.8	47.8	47.2
SD	1.68	2.05	2.50	4.84	1.52
IVDMD:					
Range	47.7-59.5	43.5-61.5	36.3-62.4	46.5-56.4	46.1-50.7
Mean	55.0	55.5	53.9	51.1	48.7
SD	3.24	3.28	4.14	3.86	1.87

[a].Nutritional quality was based on the following measures; CP = crude protein, ADIN = acid detergent insoluble nitrogen, NDF = neutral detergent fiber, ADF = acid detergent fiber, IVDMD = invitro dry matter digestibility. Precipitation was a measure of exposure of the residues between swathing and baling/storage.

enzymes; it is highly correlated to true digestibility. In this survey, perennial ryegrass and bentgrass had the highest in vitro dry matter digestibilities compared to annual ryegrass and orchardgrass, with tall fescue being intermediate ($P<.05$) (Table 1). Therefore, as expected, straws that have a higher fiber content also displayed a lower digestibility.

Ergovaline concentration. Ergovaline is an ergopeptide alkaloid produced by the fungal endophyte, *Acremonium coenophialum*. This endophyte has been introduced into some turf-type tall fescue and perennial ryegrass varieties because of the potential increases in plant hardiness, pest resistance, and drought tolerance imparted by this fungus.

Ergovaline has been implicated in producing deleterious effects when consumed by livestock, particularly ruminant animals and horses. Effects on ruminants include lowered prolactin levels, increased respiration rates, long-dull-rough hair coats, lower feed intakes, lower weight gains, higher rectal temperatures, decreased heart rates, decreased skin surface temperatures of the extremities such as ears, tails, and lower legs, fat necrosis, fescue foot, decreased ruminal fiber digestion, and increased sensitivity to heat. In horses, alkaloid consumption has caused reproductive

Table 2. Ergovaline Content of Tall Fescue and Perennial Ryegrass Varieties[a]

Species	Variety	Number of samples	Range (ppb)	Mean (ppb)	Standard Deviation
Tall Fescue	Arid	8	0-115	35.6	50.1
	Clemfine	3	0-345	201.7	179.8
	Falcon	9	0-130	33.3	48.3
	Mustang	5	85-140	102	22.0
	Rebel II	4	25-210	118.8	75.7
	Titan	6	105-945	551.7	347.7
	Tribute	3	365-680	511.7	158.6
	Trident	5	56-194	123.4	50.9
Perennial Ryegrass	C-21	6	0-90	44.7	37.1
	Charger	4	55-200	128.8	69.7
	Cowboy	4	185-500	362.5	141.8
	Dasher II	3	80-765	386.7	348.1
	Envy	3	60-85	70	13.2
	Fineleaf	5	50-225	109.6	71.5
	Linn	4	75-210	118.8	62.8
	Manhattan II	4	390-790	582.5	199.5
	Palmer	5	105-185	129	32.3
	Pinnacle	3	0-430	181.7	222.6
	Pennant	3	33-425	196	204.2
	Premiere	6	0-440	111.3	165.5
	Riveria	3	400-410	405	5.0
	Seville	3	393-645	502.7	129.1
	SR 4100	5	255-550	378	111.6
	SR 4200	4	240-450	338.8	86.3
	Sunrye	6	0-478	270.5	183.2

[a] Only varieties with three or more samples are reported here.

problems such as agalactia, thick placentas, spontaneous abortions, dead or weak foals at birth, and rebreeding problems. The feedstuffs utilized in these research studies have been seeds, moderate-to-good quality hays, and pastures. No data exists on alkaloid content in grass seed straw.

In this survey, mean ergovaline concentrations for tall fescue and perennial ryegrass were 86 and 214 ppb, respectively. Of the fescue fields sampled, 14 percent had ergovaline levels greater than 200 ppb while 42 percent of the perennial ryegrass contained ergovaline levels greater than 200 ppb. A list of the tall fescue and perennial ryegrass varieties with measurable ergovaline levels is shown in Table 2. All the varieties in the table are turf-type grasses with the exception of Linn perennial ryegrass, which is a forage-type grass. Identification of tall fescue and perennial ryegrass varieties that may contain high alkaloid levels is important when utilizing these straws as a feed. This research suggests high variation within varieties. For example, Titan tall fescue has a alkaloid concentration range from 105 to 945 ppb, with a standard deviation of $\pm$ 347.7. Thus, the identification of species varieties does not tell the whole story. There is a need to identify factors that influence ergovaline concentration beyond variety.

CONCLUSIONS

Not surprisingly, the grass seed residues harvested in the greatest amount for livestock feed are also the residues of the greatest nutritional value (perennial ryegrass, tall fescue and bentgrass). Ergovaline alkaloid is present in tall fescue, perennial ryegrass, and other fescues. However, only a small percentage of tall fescue had levels that indicate a cause for concern. The following report pertains to the feeding of high alkaloid residues on beef cattle nutrition, health, and performance.