Feeding Ryegrass Silage in the South East US

John K. Bernard
Department of Animal and Dairy Science
The University of Georgia
Tifton, GA

Ryegrass is a highly nutritious grass that can be utilized for grazing or production of baleage, haylage, or hay. In contrast to many regions of the world that are suitable for production of perennial ryegrass, annual ryegrass varieties are best suited for use in the Southeast US. When properly managed, annual ryegrass provides moderate concentrations of degradable protein. Annual ryegrass is highly digestible providing large quantities of digestible energy in support of animal growth or milk production. Feeding programs should be designed to utilize the digestible nutrients provided by ryegrass. This presentation will review the changes in nutrient content of annual ryegrass as it matures and supplementation strategies to better utilize nutrients in rations fed to lactating dairy cows.

Nutrient Composition and Digestibility

The effect of the stage of maturity on the nutrient composition of annual ryegrass is summarized in Table 1. Forage quality declines as the stage of maturity advances. Concentrations of crude protein (CP) are highest and ADF lowest when annual ryegrass is in the vegetative stage of maturity. As maturity advances, concentrations of CP decrease whereas ADF increases. In contrast, the concentration of sugar (water-soluble carbohydrate) is highest during the boot and bloom stage of maturity and lowest during late vegetative and mature stages of maturity. Harvesting annual ryegrass at the boot or early bloom stage of maturity provides adequate concentrations of sugars needed for fermentation. Because sugar concentrations decline with advancing maturity, baleage or haylage produced from more mature annual ryegrass is harder to preserve and frequently has higher pH and tends to mold.

Table 1. Nutrient composition of annual ryegrass[1]

Stage of maturity	WSC[2]	CP	ADF	NE_l[3]
	------- % of DM -------			
Late vegetative	15.4	18.8	27.6	0.75
Boot	26.6	18.7	33.1	0.68
Bloom	26.5	13.1	35.6	0.64
Milk/dough	24.3	11.9	35.4	0.64
Mature	11.6	8.6	39.2	0.60

[1]Adapted from McCormick et al. 2002.
[2]Water-soluble carbohydrate.
[3]Calculated as (1.085 - (0.0124 x ADF)).

The digestibility of ryegrass silage is typically higher than other winter annuals. Researchers in Israel reported NDF digestibilities of 49.6 and 64.1% for diets based on wheat silage and ryegrass silage, respectively (Ben-Ghedilia et al. 1995). McCormick et al. (2002) reported *in vitro* true DM digestibilities of 79.2 and 78.7% for haylage and baleage harvested in the boot stage of maturity. The high digestibility of DM and NDF in ryegrass is related to the lower concentrations of lignin and greater proportions of mesophyl and parenchymatic tissue which is more degradable compared with the composition of other winter annuals (Ben-Ghedalia et al., 1995). Perennial ryegrass has greater concentrations of potential digestible NDF than alfalfa silage, but the passage rate is lower which tends to depress DMI (Hoffman et al., 1998).

Harvesting ryegrass as silage allows the production of higher quality forage than hay. The higher quality is due primarily to harvesting at a more optimum stage of maturity. Harvesting ryegrass as silage also reduces the potential for rain damage and allows earlier planting of another crop. When producing silage, ryegrass should be wilted before chopping to increase the dry matter content to at least 30% to reduce runoff. This also improves fermentation and stability of the resulting silage. The protein in ryegrass silage is very degradable (Van Vuuren et al., 1990), thus attention should be given to providing adequate amounts of fermentable carbohydrates to improve utilization of the nitrogen provided by ryegrass silage. Supplements which provide fermentable carbohydrate could be either forage or concentrate.

Supplemental forage and grain

Previous research has shown that feeding a blend of alfalfa silage and corn silage improves milk yield and efficiency of protein utilization compared to feeding diets bases only on alfalfa silage (Dhiman and Satter, 1997). In another trial, a blend of 75% corn silage and 25% grass-legume silage supported higher yields of milk, fat, and protein compared with diets based on corn silage or a 50:50 blend of corn silage and grass-legume silage (Keys et al., 1984). Legumes typically have a higher passage rate and support higher DMI and milk yield than grasses (Broderick et al. 2002; Hoffman et al., 1998).

Fermentable energy supplements should be used in diets containing ryegrass silage to improve the efficiency of protein utilization which would also improve milk yield and reduce the amount of nitrogen excreted. European researchers observed that fermentable byproducts such as beet pulp were more effective in lowering ruminal ammonia concentrations than corn supplementation because of the amount of corn starch that escaped ruminal fermentation (Van Vuuren et al., 1993; De Visser et al., 1998).

Over the past three years, we have conducted a series of trials with ryegrass silage-based diets to examine the effects of forage combinations and supplemental grain source. Trial 1 was conducted to determine the effects of feeding varying combinations of ryegrass silage and corn silage. Ryegrass silage was harvested in the boot stage of maturity and corn silage

Table 2. Chemical composition of ryegrass silage and corn silage used in Trials 1 and 2.

	Trial 1		Trial 2	
	Corn silage	Ryegrass silage	Corn silage	Ryegrass silage
	% of DM			
Ash	4.3	10.2	5.3	28.6
CP	8.0	10.0	8.5	20.3
NDF	40.2	55.6	41.9	43.6
IVTDMD	67.0	72.7		

was harvested at approximately 2/3 milk line. The chemical composition of the forages is summarized in Table 2. Diets contained 55% forage provided by corn silage and ryegrass silage in the following proportions: 0:100; 35:65; 65:35; or 100:0. Twenty late lactation Holstein cows were fed the diets in an 8-week trial. As ryegrass silage increased in the diet, yield of milk, fat, protein, and energy-corrected milk yield (ECM) increased in a linear fashion (Table 3). The DMI was numerically higher for the two diets with the highest proportions of ryegrass silage. The diets based primarily on corn silage were low fiber diets that would potentially cause subclinical acidosis. Substituting the ryegrass silage would have improved ruminal pH and fermentation and support greater milk yield.

Table 3. Effects of feeding different proportions of corn silage (CS) and ryegrass silage (RS) (Trial 1).

	Proportions of CS and RS				
	100:0	65:35	35:65	0:100	SE
	------------------------ lb/d		--------------------------		
DMI	41.2	41.0	46.3	45.0	2.4
Milk	48.1	50.5	56.9	61.9	3.1[a]
Fat	4.81	2.05	2.07	2.47	0.31[a]
Protein	1.61	1.76	1.87	2.07	0.22[a]
ECM	51.4	52.7	59.1	67.2	3.1[a]

[a]Linear response (P < 0.01)
Bernard et al., 2002.

In Trial 2, ryegrass silage was harvested in the late vegetative stage of maturity and was of high quality than that used in Trial 1 (Table 2). Diets for the trial were formulated to contain 49.6% forage from either ryegrass silage or a 50:50 blend of ryegrass silage and corn silage and supplemented with either ground corn or steam-flaked corn. Twenty-four mid-lactation Holstein cows were used in a 6-week trial. Dry matter intake and ECM yield were increased by feeding a combination of ryegrass silage and corn silage compared with feeding only ryegrass silage (Table 4). Supplementation with steam-flaked corn decreased DMI but increased yields of milk and ECM compared with ground corn. Blood urea nitrogen was lower for cows fed steam-flaked corn compared with ground corn (15.6 versus 18.2 mg/dl, respectively) reflecting improved dietary nitrogen utilization. Digestibility of organic matter (OM), ADF, and NDF were decreased by feeding a combination of both ryegrass silage and corn silage. Digestibility of OM was improved when steam-flaked corn compared with ground corn, especially on diets based on ryegrass silage (Table 4). In contrast with the first trial, the combination of ryegrass silage and corn silage was more desirable than ryegrass alone. The corn silage used in this trial contained more fiber and was not as finely chopped. The improvements observed when steam-flaked corn was fed reflect greater starch digestibility in the rumen.

Table 4. Effect of forage and corn processing on production and nutrient digestibility (Trial 2).

Forage	RG[1]	RG	BOTH	BOTH	
Corn	GC	SFC	GC	SFC	SE
Production					
DMI, lb/d[ab]	44.6	42.2	50.5	47.7	1.1
Milk, lb/d[b]	65.2	70.5	66.0	72.9	1.7
Fat, %	3.46	3.10	3.71	3.11	0.28
Protein, %	2.84	2.86	2.85	2.75	0.06
ECM, lb/d[ab]	58.4	63.4	68.4	69.0	4.0
EFF[1]	1.47	1.67	1.31	1.54	0.05
Digestibility					
OM, %[cd]	69.45	79.95	67.44	70.08	2.74
CP, %	63.85	73.86	67.11	66.51	2.92
ADF, %[c]	50.47	55.74	47.85	44.09	2.87
NDF, %[c]	47.87	55.85	39.02	34.73	3.58

[a]Forage response ($P < 0.01$).
[b]Corn response (P 0.01).
[c]Forage response ($P < 0.05$).
[d]Corn response (P 0.05).
[1]RG = ryegrass silage; BOTH = 50:50 blend of corn silage and RG; EFF = efficiency of milk production (lb milk/lb DMI).

Trial 3 examined combinations of corn silage and ryegrass silage supplemented with either ground corn, steam-flaked corn or hominy. The chemical composition of the main ingredients is provided in Table 5. Experimental diets were fed to 48 lactating Holstein cows in a 6-week trial. There were no interactions between forage combinations and energy supplements. As observed previously, DMI was higher for diets containing both ryegrass silage and corn silage than the diet based on ryegrass silage (Table 6). Milk protein percentage increased as the proportion of corn silage in the diet increased. No differences were observed in the yield of milk and ECM among forage combinations. The DMI was lowest for the diets supplemented with steam-flaked corn (Table 7). Milk fat percentage was lowest for the diet supplemented with hominy compared with ground corn and steam-flaked corn. No differences were observed in milk protein percentage or yield of components.

Table 5. Chemical composition of primary ingredients fed in Trial 3.

	CS[1]	RS	GC	SFC	HO
Ash	5.7	20.7	3.1	2.6	2.1
CP	9.2	19.0	10.1	10.4	10.4
NDF	42.1	45.2	14.9	13.3	25.7
Starch			64.1	67.4	47.2

[1]CS = corn silage; RS = ryegrass silage; GC = ground corn; SFC = steam-flaked corn; HO = hominy

Table 6. Effect of proportion of ryegrass (RS) and corn silage (CS) on performance (Trial 3).

	Proportion of RS and CS				
	100:0	75:25	50:50	25:75	SE
DMI, lb/d [a]	45.7	47.9	47.9	48.8	0.8
Milk, lb/d	66.1	71.2	67.8	69.7	1.7
Fat, %	4.01	3.91	3.63	3.90	0.14
Protein, %[a]	2.85	2.85	2.92	3.00	0.03
ECM, lb/d	69.9	71.9	66.8	72.0	3.0
Efficiency	1.52	1.51	1.39	1.46	0.06

[a]Linear effect ($P < 0.01$).

Table 7. Effect of supplemental ground corn (GC), steam-flaked corn (SFC) or hominy (HO) on performance of lactating Holstein cows (Trial 3).

	GC	SFC	HO	SE
DMI, lb/d [a]	49.1[a]	46.2[b]	47.4[ab]	0.8
Milk, lb/d	69.6	67.9	68.5	1.6
Fat, %	4.07[a]	3.82[ab]	3.70[b]	0.13
Protein, %[a]	2.89	2.91	2.91	0.03
ECM, lb/d	72.7	70.5	67.2	2.6
Efficiency	1.48	1.52	1.42	0.05

[ab]Means in the same row with different superscripts differ ($P < 0.05$).

Trial 4 was conducted to examine the effect of energy supplement when diets contained a 50:50 blend of ryegrass silage and corn silage using 24 lactating Holstein cows in mid-lactation. Forage was the same as that used in trial 3. Cows fed the diet supplemented with steam-flaked corn consumed less DM than those fed ground corn or hominy. Milk yield and composition was similar for all treatments. The efficiency of converting DMI into milk was highest for the diet supplemented with steam-flaked corn.

Table 8. Effect of supplemental ground corn (GC), steam-flaked corn (SFC) or hominy (HO) on performance of lactating Holstein cows (Trial 4).

	GC	SFC	HO	SE
DMI, lb/d	56.3[a]	50.7[b]	56.7[a]	1.7
Milk, lb/d	68.8	70.2	71.5	1.8
Fat, %	4.16	4.10	4.00	0.15
Protein, %	3.18	3.19	3.13	0.04
ECM, lb/d	74.0	74.7	76.1	2.3
Efficiency	1.32[b]	1.47[a]	1.35[b]	0.04

[ab]Means in the same row with different superscripts differ ($P < 0.05$).

Summary

Ryegrass silage is a highly digestible forage that can work well in diets fed to lactating cows. Feeding a combination of ryegrass silage and corn silage improves DMI and tends to increase milk yield and milk protein percentage. Feeding a combination of ryegrass silage and corn silage tends to lower nutrient digestibility possibly due to differences in intake and negative associative effects. Results of the trials we have conducted do not suggest that any one ratio of ryegrass silage to corn silage is more desirable than another. The proportions used should be based on amounts of forage available and rates required to minimize spoilage.

Supplementation of diets containing ryegrass silage with steam-flaked corn decreased DMI without altering milk yield which improved the efficiency of conversion of DM to milk. Increases in milk yield when steam-flaked corn was fed were noted in one trial, but these results were not repeated in subsequent trials. Supplementation of diets with hominy tended to decrease milk fat percentage. Additional research is needed to examine the potential of feeding combinations of energy supplements differing in ruminal fermentability as well as the potential effect of sugar content of ryegrass silage on responses.

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