Using Eastern Gamagrass to Limit Weight Gains by Replacement Dairy Heifers: 1. Nutrient Intakes and Heifer Performance

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ABSTRACT

Previous research has shown that eastern gamagrass [EGG; *Tripsacum dactyloides* (L.) L.] will produce yields of DM in central Wisconsin ranging from 7,000 to 10,000 kg ha^{-1} annually when managed with a 1-cut harvest system. Our objective was to determine whether the fibrous nature of this perennial warm-season grass could reduce the caloric density and DM intakes of corn silage/alfalfa haylage diets for replacement dairy heifers. A total of 120 Holstein dairy heifers were blocked by weight (heavy, 424 ± 15.9 kg; medium, 369 ± 11.8 kg; light, 324 ± 22.4 kg), and then assigned to 15 individual pens comprised of 8 heifers per pen. Eastern gamagrass haylage was blended into corn silage/alfalfa haylage diets at rates of 0, 9.2, 18.4, or 27.6% of the total dietary DM (EGG0, EGG9, EGG18, and EGG27, respectively). These diets were offered for ad-libitum intake during a 105-d evaluation period; however, the EGG0 diet also was offered on a limit-fed basis (LF). Serial additions of EGG increased NDF in the blended diets from 396 g kg^{-1} (EGG0) to 487 g kg^{-1} (EGG27), and reduced corresponding estimates of energy density from 682 to 613 g kg^{-1} TDN. Intakes of DM for all ad-libitum diets were greater than LF (9.06 vs. 8.07 kg d^{-1}; $P < 0.001$); however DM intakes for diets containing EGG were reduced relative to EGG0 (9.40 vs. 8.94 kg d^{-1}; $P = 0.001$). Similar effects were observed for intakes of TDN. Over the 105-d trial, total weight gains ranged from 89 kg (0.85 kg d^{-1}) for heifers offered EGG27 up to 114 kg (1.09 kg d^{-1}) for those offered EGG0. Performance was numerically similar between heifers offered EGG27 and LF diets (0.85 vs. 0.88 kg d^{-1}). Eastern gamagrass haylage was a completely non-sortable additive within corn silage/alfalfa haylage diets, and limited undesirable weight gains by dairy heifers.

INTRODUCTION

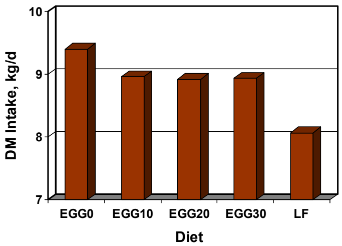
Throughout much of the US, corn silage is the most economical forage to grow for dairy heifers. Although diets containing corn silage can increase average daily gain, this practice also can be counterproductive. For example, increased pre-pubertal average daily gain (ADG) is known to have a negative effect on mammary development and first-lactation milk yield. Generally these problems arise because corn silage is energy dense and often exceeds the energy requirements for dairy heifers; frequently, this results in over-conditioning. A common approach to resolving this problem has been to add chopped straw to the corn-silage-based diet. Unfortunately, straw often is sorted by heifers, frequently must be purchased, and the price of straw has risen due to increased competition for use in both heifer and lactating-cow diets. Other agronomic options may exist for limiting the caloric intake in heifer diets; in particular, perennial warm-season grasses have nutritive characteristics that are consistent with low-caloric content. Among these characteristics, high concentrations of forage fiber also have the potential to limit intake of DM on the basis of gut fill. Eastern gamagrass is a native warm-season grass known for its high production potential, responsiveness to nitrogen fertilization, and proven suitability for silage fermentation. Recent work has shown that DM yields ranging from 7,000 to 10,000 kg ha^{-1} are possible with a 1-cut system throughout central Wisconsin. Our objective was to determine whether the fibrous nature of this perennial warm-season grass could reduce the caloric density and DM intakes of corn silage/alfalfa haylage diets for replacement dairy heifers.

Table 1. Formulation of diets for replacement dairy heifers.

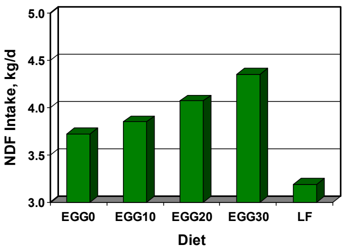
Item	Blended Diets[1] EGG0	EGG9	EGG18	EGG27	LF	Dietary Components Alfalfa Haylage	Corn Silage	EGG Haylage
Ingredient, % of DM								
Alfalfa Haylage	46.5	45.8	44.6	43.4	46.5	. . .	. . .	. . .
Corn Silage	52.9	44.4	36.5	28.5	52.9	. . .	. . .	. . .
EGG Haylage	0.0	9.1	18.3	27.4	0.0	. . .	. . .	. . .
Mineral[2]	0.6	0.6	0.6	0.6	0.6			
Nutrient Composition, g kg^{-1}								
DM	401	399	405	406	401	442	381	396
CP	129	130	131	129	129	202	67	82
NDF[3]	396	430	456	487	396	411	380	697
ADF[3]	269	288	304	315	269	330	217	392
Hemicellulose[3]	127	142	152	172	127	81	163	305
Lignin[3]	45	50	52	53	45	67	25	54
Starch	179	159	125	109	179	10	352	22
Ash	74	75	78	78	74	109	35	56
P	2.5	2.6	2.6	2.8	2.5	3.1	2.3	2.0
Ca	7.2	7.2	7.4	6.9	7.2	9.8	1.9	2.3
Energy Estimates[4]								
TDN, g kg^{-1}	682	653	632	613	682	607	724	520
ME, Mcal kg^{-1}	2.59	2.46	2.36	2.28	2.59	2.26	2.77	1.87
NE_G, Mcal kg^{-1}	1.07	0.97	0.90	0.83	1.07	0.81	1.21	0.47
NE_M, Mcal kg^{-1}	1.68	1.57	1.49	1.41	1.68	1.39	1.84	1.02

[1] Abbreviations: EGG0 = alfalfa haylage/corn silage diet containing no EGG offered for ad-libitum intake; EGG9 = alfalfa haylage/corn silage diet containing 9.2% EGG offered for ad-libitum intake; EGG18 = alfalfa haylage/corn silage diet containing 18.4% EGG offered for ad-libitum intake; EGG27 = alfalfa haylage/corn silage diet containing 27.6% EGG offered for ad-libitum intake; and LF = EGG0 diet offered at 85% of DMI for EGG0.
[2] Mineral package contained 72.1% calcium carbonate, 16.5% salt, 3.35% sulfur, 2.95% selenium 1600, 1.50% Vitamin A, 0.75% mineral oil, 0.71% copper sulfate, 0.69% Vitamin E (50%), 0.64% zinc sulfate, 0.51% Vitamin D, 0.09% iodine mix, 0.005% magnesium sulfate, 0.005% cobalt carbonate, 0.005% manganese oxide (60%), and 0.26% thiamine. Mineral package was blended into the total diet and delivered as a TMR.
[3] NDF, ADF, and acid-detergent lignin were determined sequentially, without sulfite added to the NDF solution.
[4] Energy calculations based on NRC (2001).

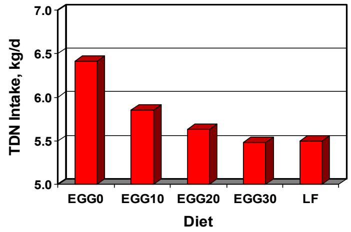
Heifers were blocked on bodyweight (heavy, 424 ± 15.9 kg; medium, 369 ± 11.8 kg; light, 324 ± 22.4 kg), and housed in 15 identical pens equipped with an automated alley-scrapping system, 8 sand-bedded freestalls, and 8 locking headgates adjacent to the feed alley. Procedures for animal care were approved by the Research Animal Resources Center of the University of Wisconsin-Madison (Protocol #A01458).



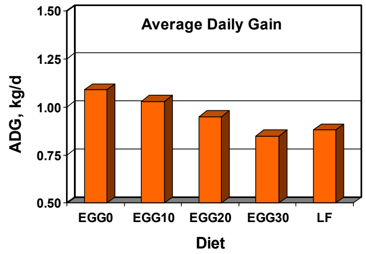
DM Intake, kg/d (SEM = 0.078)
LF vs. Full Feed, $P < 0.001$
EGG0 vs. EGG10, 20, and 30, $P = 0.001$
EGG Linear, $P = 0.004$
EGG Quadratic, $P = 0.018$



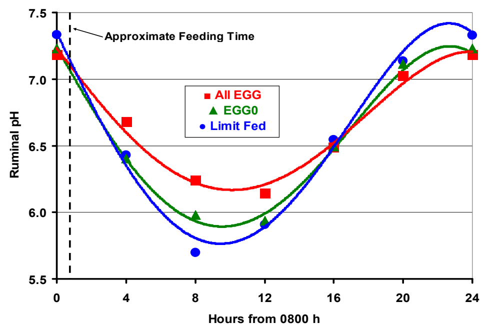
NDF Intake, kg/d (SEM = 0.035)
LF vs. Full Feed, $P < 0.001$
EGG0 vs. EGG10, 20, and 30, $P < 0.001$
EGG Linear, $P < 0.001$



TDN Intake, kg/d (SEM = 0.053)
LF vs. Full Feed, $P < 0.001$
EGG0 vs. EGG10, 20, and 30, $P < 0.001$
EGG Linear, $P < 0.001$
EGG Quadratic, $P = 0.005$



Average Daily Gain, kg/d (SEM = 0.021)
LF vs. Full Feed, $P = 0.003$
EGG0 vs. EGG10, 20, and 30, $P < 0.001$
EGG Linear, $P < 0.001$



Regression lines depicting ruminal pH responses over a 24-h diurnal cycle for heifers consuming: i) EGG0 ($Y = -0.000039x^4 + 0.0013x^3 - 0.23x + 7.24$; $R^2 = 0.997$); ii) LF at 85% of the voluntary DM intake of EGG0 ($Y = -0.000047x^4 + 0.0016x^3 - 0.27x + 7.40$; $R^2 = 0.991$); or iii) EGG9, EGG18, or EGG27. Ruminal pH reached a similar minimum for the 3 diets containing EGG; for clarity of presentation, regression was conducted on the mean response (ALL EGG) for these diets ($Y = -0.000025x^4 + 0.00089x^3 - 0.17x + 7.23$; $R^2 = 0.927$).

CONCLUSIONS

Based on our results, EGG was effective in limiting caloric intakes by dairy heifers, and this was accomplished by diluting both the energy density of the diet, as well as restricting DM intakes on the basis of gut fill by increasing dietary NDF. The practical benefit of reducing energy intakes was a subsequent linear reduction of ADG, and amounted to about 0.01 kg d^{-1} for each percentage unit of EGG in the diet. As such, it was necessary to substitute EGG primarily for corn silage until it comprised about 30% of the diet in order to reduce ADG to comparable levels with LF heifers, which was within reasonable proximity to typical ADG targets for heifers of this size. When EGG was included within the alfalfa haylage/corn silage diets developed for this trial, there was no visual evidence of undesirable sorting behaviors by heifers, which are common when chopped straw is included in the diet. This is important because a functionally non-sortable diet potentially allows for greater flexibility with respect to bunk space because less-desirable feed particles are not discriminated against, and subordinate heifers have access to the same diet as aggressive heifers, whenever they are able to reach the feedbunk.

REFERENCE

Coblentz, W. K., P. C. Hoffman, N. M Esser, and M. G. Bertram. 2012. Using eastern gamagrass to construct diets that limit intake and caloric density for dairy heifers. J. Dairy Sci. 95:6057-6071.