Evaluation of Cool Season Grass Haylage Fermented with Small Grains
(Vermont Mini-Silo Experiment)

Dairy farmers are always looking for strategies to reduce input costs. Grain purchase is an area of significant input cost for most dairy farms. Many farmers are interested in growing some of their own grain, but don't have the required grain infrastructure, such as a dryer or storage bins. Most farmers store feed in bag silo, tower silo, low-oxygen tower silo, bunker silos. Small grains such as oats and barley are well adapted to the Vermont climate and are also common feedstuffs. The goal of this experiment was to test the potential to store/handle a grain crop by mixing it with perennial forages and storing the combined feed in a common storage structure. This experiment evaluated the impact of fermentation on processed grains whole, rolled, or hammered. Forage quality was assessed and compared with standard practices.

MATERIALS AND METHODS

The mini-silos were constructed on July 15, 2011 by using a 4" by 24" PVC pipe, and two rubber caps, one on the bottom, and one on top. Each mini-silo was designed to be air-tight and impervious to light to represent a tower silo. Each mini-silo was filled with a 5 to 1 ratio of haylage to grain, dry matter basis. Silos were filled with 3.6 pounds of haylage with 48% moisture and 0.48 pounds of grain such as oats, barley, and shell corn at 14% moisture. Grains were either hammer milled, rolled, or whole kernel. The corn could not be rolled because the seed or kernel was too hard to place in the roller device each treatment was replicated four times. Silos with alfalfa/tall fescue served as a control treatment. The silo contents were mixed with a small tumbler mixer to evenly mix the recipe. Once mixed properly, the recipe was placed in the PVC tube and placed under a SP 56(silage packer) to be packed like a farmer's silo. Once mixed and packed, the mini-silo received a rubber cap with a 4-inch hose clamp, and placed in a rack to being its fermentation process. A month after the mini-silos had been fermenting, they were opened, subsampled and placed in a 10" by 13" Mil poly nylon bag and vacuumed sealed using a Uline 20" model H-175 and shipped to Cumberland Valley Forage Laboratory in Hagerstown, Maryland for quality analysis.

Table 1. Forage and grain treatments incubated in mini-silos.

Forage	Grain and process methods	Treatment
Alfalfa/tall fescue	Hammer milled barley	HHMB
Alfalfa/tall fescue	Hammer milled corn	HHMC
Alfalfa/tall fescue	Hammer milled oats	HHMO
Alfalfa/tall fescue	No grain added controlled treatment	H
Alfalfa/tall fescue	Rolled barley	HRB
Alfalfa/tall fescue	Rolled oats	HRO
Alfalfa/tall fescue	Whole kernel barley	HB
Alfalfa/tall fescue	Whole kernel corn	HC
Alfalfa/tall fescue	Whole kernel oats	HO

Table 2. Agronomic information for alfalfa/tall fescue forage.

Trial information	Borderview Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Alfalfa/tall fescue
Harvest date	7/14/2011
Fertilizer	50lb N ac 21-0-0 6-42011

Silage quality was analyzed using wet chemistry techniques at the Cumberland Valley Forage Laboratory in Hagerstown, MD. sub samples were dried, ground and analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and 30h digestible NDF (dNDF). Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the CP content of forages. The CP content of forages is determined by measuring the amount of N and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. Recently, forage testing laboratories have begun to evaluate forages for NDF digestibility. Evaluation of forages and other feedstuffs for NDF digestibility is being conducted to aid prediction of feed energy content and animal performance. Research has demonstrated that lactating dairy cows will eat more dry matter and produce more milk when fed forages with optimum NDF digestibility. Forages with increased NDF digestibility will result in higher energy values, and perhaps more importantly, increased forage intakes. Forage NDF digestibility can range from 20 – 80%.

The silage performance indices of milk per acre and milk per ton were calculated using a model derived from the spreadsheet entitled, “MILK2007” developed by researchers at the University of Wisconsin. Milk per ton measures the pounds of milk that could be produced from a ton of silage. This value is generated by approximating a balanced ration meeting animal energy, protein, and fiber needs based on silage quality. The value is based on a standard cow weight and level of milk production. Milk per acre is calculated by multiplying the milk per ton value by silage dry matter yield. Therefore milk per ton is an overall indicator of forage quality and milk per acre an indicator of forage yield and quality. Milk per ton and milk per acre calculations provide relative rankings of forage samples, but should not be considered as predictive of actual milk responses in specific situations.

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine, whether a difference among varieties is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant differences (LSD’s) at the 10% level of probability are shown. Where the difference between two varieties within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two varieties. Varieties that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In the example below A is significantly different from C but not from B. The difference between A and B is equal to 1.5 which is less than the LSD value of 2.0. This means that these varieties did not differ in yield. The difference between A and C is equal to 3.0 which is greater than the LSD value of 2.0. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that B was not significantly lower than the top yielding variety.

Variety	**Yield**
A	6.0
B	7.5*
C	9.0*
LSD	2.0

RESULTS

Table 3. Quality analysis of haylage mixed with small grains.

Treatment	DM	Moist	Forage quality characteristics											
			CP	SCP	RDP	ADF	NDF	Starch		TDN	NEL	RFV	NFC	NSC
	%	%	%	%CP	%CP	%	%	%DM	%NFC	%	Mcal lb		%	%
H	54.6	**45.4***	**18.0***	**45.8***	**72.9***	32.9	50.2	2.00	10.0	61.6	0.64	117.3	20.2	2.00
HB	61.7	38.3	16.4	38.9	69.5	28.0*	44.4*	**13.4***	**46.4***	64.6*	0.67	140.7*	28.8*	**13.4***
HC	59.8	40.2	16.7	40.8	70.4	**27.3***	44.4*	12.9*	44.4*	**65.6***	**0.68***	142.7*	28.6*	12.9*
HHMB	**63.7***	36.3	16.8	36.1	68.1	27.5*	**43.8***	12.5*	43.4*	65.0*	0.67*	**143.3***	**28.9***	12.5*
HHMC	57.2	42.8	16.8	41.7	70.8	28.1*	44.2*	12.9*	45.4*	65.4*	0.68*	140.7*	28.5*	12.9*
HHMO	60.2	39.8	16.2	41.7	70.8	30.1	46.9	10.4	39.2	64.0	0.66	129.7	26.5	10.4
HO	59.4	40.6	16.7	42.9	71.4	29.2	45.8	11.4*	42.1*	65.2*	0.68*	134.7	27.2*	11.4*
HRB	61.1	38.9	16.9	41.6	70.8	29.0	45.2*	11.3*	40.9*	64.4	0.67*	136.3*	27.4*	11.3*
HRO	60.1	39.9	16.5	42.0	71.0	29.5	45.7	10.8	39.5	64.4	0.67*	134.3	27.3*	11
LSD (0.10)	1.9	1.9	0.4	2.6	1.3	1.2	1.9	2.32	5.9	1.0	0.0	7.5	2.3	2.3
Trial Mean	59.8	40.2	16.8	41.3	70.6	29.1	45.6	10.9	39.0	64.5	0.67	135.5	27.0	10.9

Table 4. Mini-silo mineral analysis.

Treatment	Ash	Ca	P	Mg	K	Na	Fe	Mn	Zn	Cu
	%	%	%	%	%	%	ppm	ppm	ppm	ppm
H	9.44	0.81	0.36	**0.29***	**2.68***	**0.06***	235.0	**90.0***	24.7	11.0
HB	8.57	0.85*	0.38*	0.25	2.22	0.05	212.0	72.3	26.3*	10.7
HC	8.14*	0.81	0.37	0.27	2.23	0.05*	233.3	77.7	25.7	10.3
HHMB	8.61	0.81	0.37	0.27	2.25	0.05	**289.7**	81.3	24.3	10.7
HHMC	8.23*	0.82	0.35	0.26	2.22	0.06*	224.3	76.0	24.3	10.0
HHMO	8.27*	0.88*	0.36	0.25	2.26	0.05	216.0	81.0	27.0*	12.0*
HO	**7.95***	0.88*	**0.39***	0.27	2.12	0.06*	186.3	82.3	25.7	11.3*
HRB	8.49	**0.89***	0.35	0.27	2.31	0.05*	214.7	77.7	23.7	10.7
HRO	8.25*	0.88*	0.37	0.26	2.26	0.05*	199.0	82.3	**27.3***	**12.0***
LSD (0.10)	0.45	0.06	0.01	0.01	0.1	0.01	NS	5.3	1.6	0.9
Trial mean	8.44	0.85	0.37	0.26	2.28	0.05	223.4	80.1	25.4	11.0

The levels of Net Energy Lactation (Mcal/lb) varied significantly between treatments. The treatment with the highest Nel was haylage with whole oats (HO) with 0.68 Mcal/lb. The treatment with the lowest Nel was haylage (H) with 0.64 Mcal/lb.

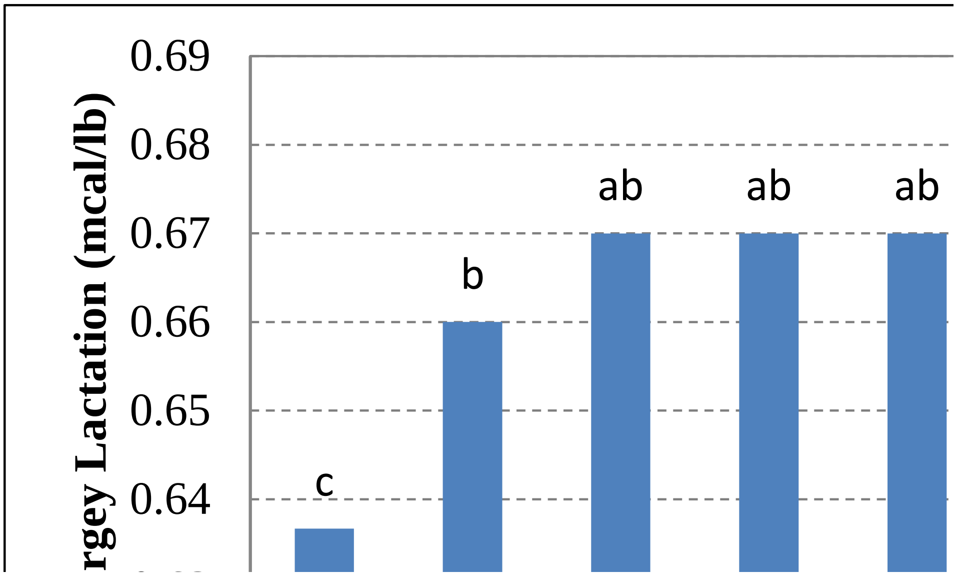

Figure 1. NEL of haylage and haylage mixed with processed grains fermented in a mini-silo..

Quality analysis of the forages also revealed a significant difference between treatments with respect to Total Digestible Nutrients (TDN). The treatment with the highest TDN was HC with 65.6 %. The treatment with the lowest TDN was H with 61.6%. Although this was the lowest TDN the other treatments were not significantly higher than HC. HB, HHMB, HHMC, HO, HRB, and HRO did not differ significantly from HC (figure 1).

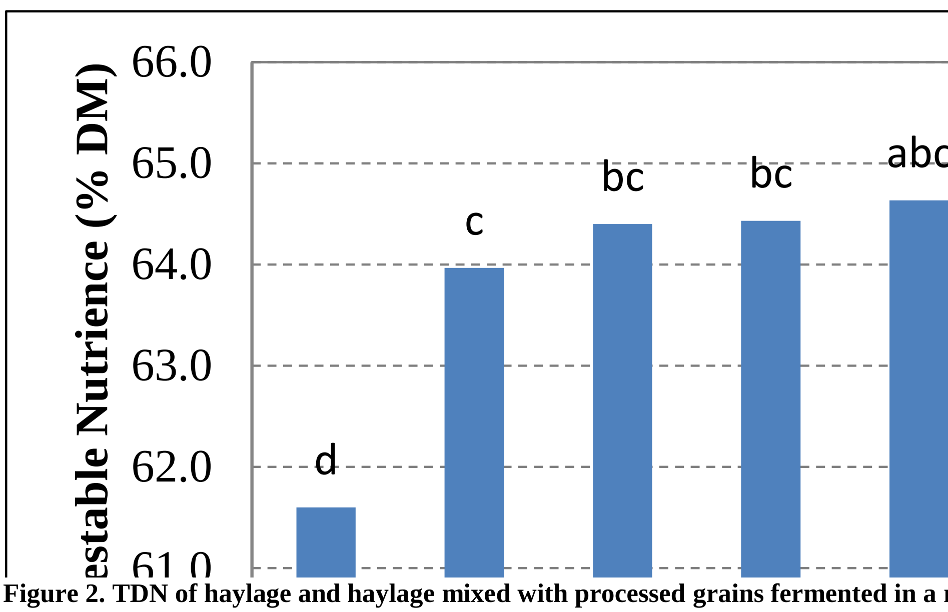

Figure 2. TDN of haylage and haylage mixed with processed grains fermented in a mini-silo.

The mini-silo treatments showed significant difference in starch. The treatment with the highest percent starch was HB with 13.4%. The treatment with the lowest percent starch was H with a total of 2.0%.

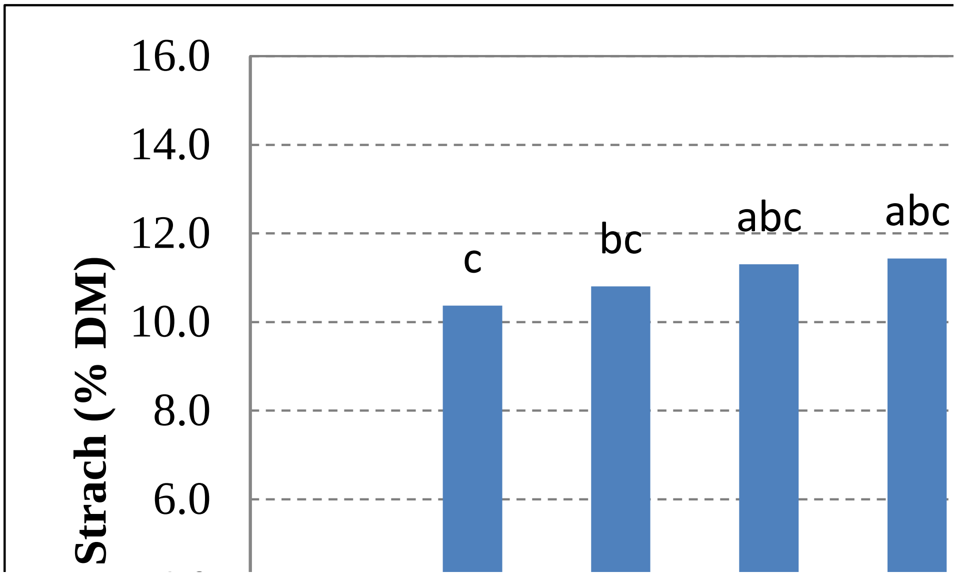

Figure 3. Starch of haylage and haylage mixed with processed grains fermented in a mini-silo.

HB was the highest in Non-Structural Carbohydrates (NSC) which yielded at 13.4%. The treatment with the lowest NSC was H with 2.0%. Two treatments H and HB were the only two that where either higher or lower than the other treatments.

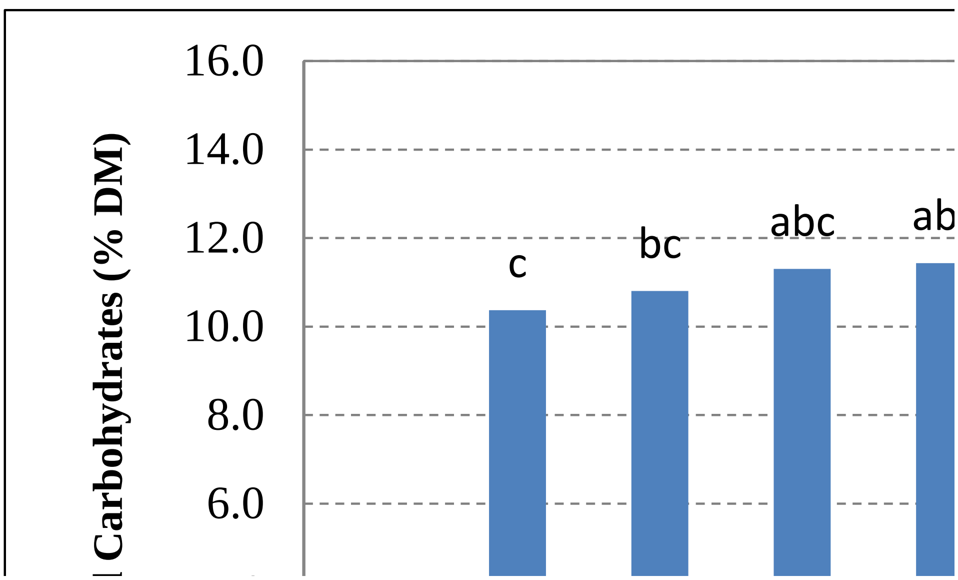

Figure 4. NSC of haylage and haylage mixed with processed grains fermented in a mini-silo.

The mini-silo trial had a controlled treatment of just haylage which in this case had the highest Neutral Detergent Fiber (NDF), which came out at 50.2%. The treatment with the lowest NDF was HHMB with 43.8%. The treatments that were statistically similar to HHMB were HB(44.4%), HC(44.4%), HHMC(44.2%), and HRB(45.2%).

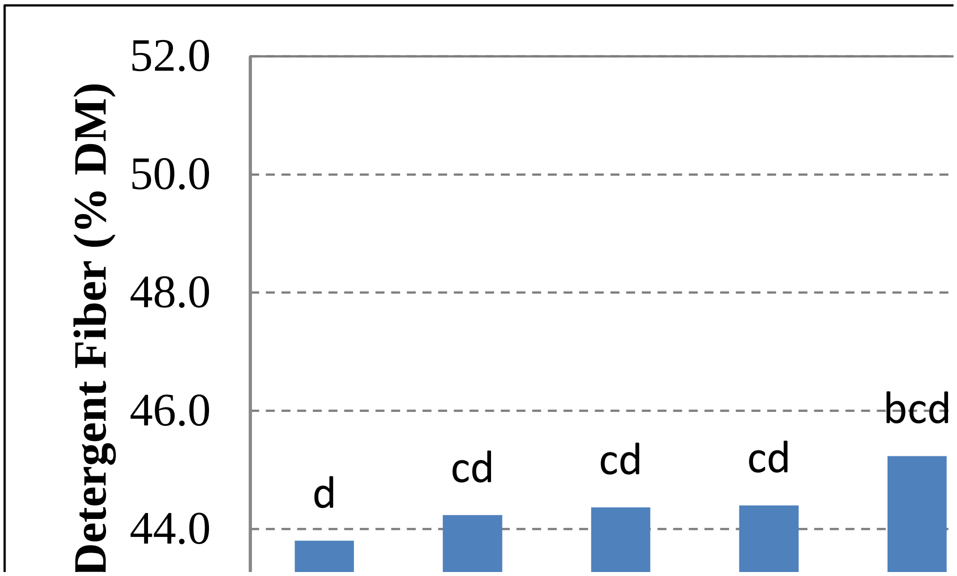

Figure 5. NDF of haylage and haylage mixed with processed grains fermented in a mini-silo.

DISCUSSION

The different treatments in the mini-silo trial were haylage (which served as a control treatment), haylage with hammer milled corn, haylage with hammer milled barley, haylage with hammer milled oats, haylage with rolled oats, haylage with rolled barley (the corn could not be rolled because it was too hard to put through the machine), haylage with whole kernel corn, haylage with whole kernel barley, and haylage with whole kernel oats. In this trial there was significant difference between the different treatments. Haylage was high in CP, Soluble Crude Protein (SCP), Rumen Detergent Protein (RDP), NDF, Magnesium (Mg),Sodium (NA), Potassium (K), and Manganese (Mn). Some treatments had higher values in some areas but lower in others. There was a feed test done with the mini-silo trial contents after they were opened. There were two feed samples fed to replacement heifers, comparing commercial feed and mini-silo feed. The cows tended to head straight towards the mini-silo feed instead of the commercial feed. Overall adding grains to consoled haylage can improve the feed quality of the forage.

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