Abstract # M111

Effects of energy supplementation for pasture forages on in vitro ruminal fermentation in continuous cultures

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Introduction

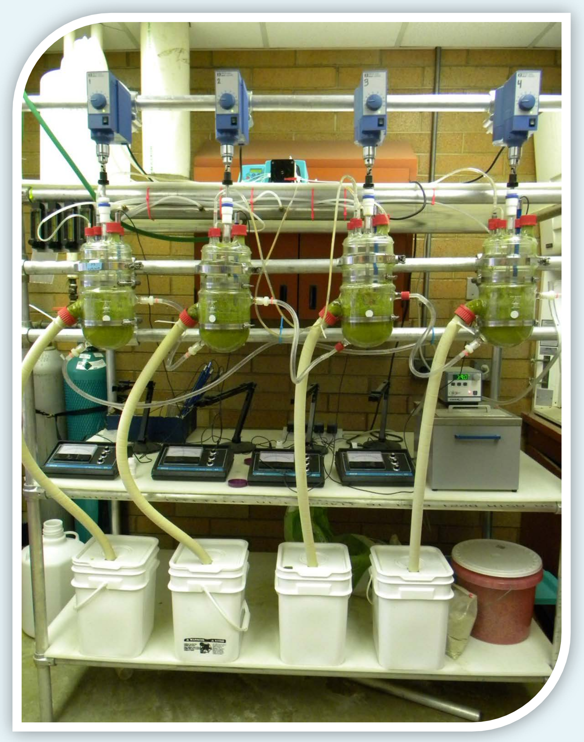
- High quality pasture forages commonly lack energy and have low N utilization efficiency in the rumen.
- Energy supplementation of forage diets improves N utilization efficiency and fermentation profiles, and reduces methane (**CH_4**) emissions.
- Starch-based energy supplements, such as corn grain, cause depressions in forage intake and decrease fiber digestibility.
- Dried distillers grains with solubles (**DDGS**) contain high concentration of readily digestible fiber, which allows this product to serve as partial replacement for forages as well as for concentrates in diets of dairy and beef cattle.
- Birdsfoot trefoil (**BFT**) has condensed tannins (**CT**) which can increase N utilization efficiency and reduce CH_4 production.
- Mixed pasture consisting of grass (tall fescue: **TF**) and BFT would be beneficial to improve N utilization by dairy cows.

Objective

- To assess in vitro ruminal fermentation characteristics by supplementing ground corn or DDGS in grass monocultures [TF without (**TF–NF**) or with N fertilizer (**TF+NF**)] and low- [TF and alfalfa (**TF+ALF**)] and high-CT grass-legume (**TF+BFT**) mixtures.

Materials & Methods

- Control (no energy supplement) and 2 types of energy supplementation (30% DM ground corn and 30% DM DDGS) combined with 4 types of pasture forage (TF–NF, TF+NF, TF+ALF, and TF+BFT), resulted in 12 dietary treatments.
- Treatments tested in a split-plot design with energy supplementation as a whole plot and pasture forage as a subplot, with 3 replicated runs (n = 3).
- Each run lasted 10 d, having 7 d of treatment adaptation and 3 d of data collection.



- Artificial saliva delivered at a rate of 6.3%/h.
- Anaerobic condition maintained by CO_2 flow at 20 mL/min.
- Each fermentor received a total of 15 g DM/d divided in 4 equal portions and fed at 0600, 1200, 1800, and 2400 h. Two equal portions of energy supplements fed at 1200 and 2400 h.
- Culture contents analyzed for VFA, NH_3-N, and microbial N.
- Headspace gas analyzed for CH_4.

Table 1. Nutrient composition (% DM) of dietary treatments.

Item	Dietary treatment[1]											
	No energy				Corn				DDGS			
	TF–NF	TF+NF	TF+ALF	TF+BFT	TF–NF	TF+NF	TF+ALF	TF+BFT	TF–NF	TF+NF	TF+ALF	TF+BFT
CP	13.5	15.5	16.3	17.8	12.1	13.5	14.0	14.5	17.7	19.6	19.4	20.3
EE[2]	2.70	2.54	2.68	2.77	2.81	2.88	2.66	3.02	5.50	5.57	5.55	5.73
NDF	56.8	56.7	51.4	52.6	45.7	45.4	43.6	42.6	51.8	50.5	49.8	49.3
ADF	31.7	31.4	30.1	31.4	21.9	21.2	23.3	22.0	25.6	24.2	26.6	25.1
NFC[3]	13.6	12.1	18.0	15.5	30.6	30.1	31.6	32.2	18.3	17.8	19.1	18.5
CT[4]	0.95	0.47	0.60	2.57	0.67	0.82	0.74	1.77	0.55	1.17	0.92	1.55

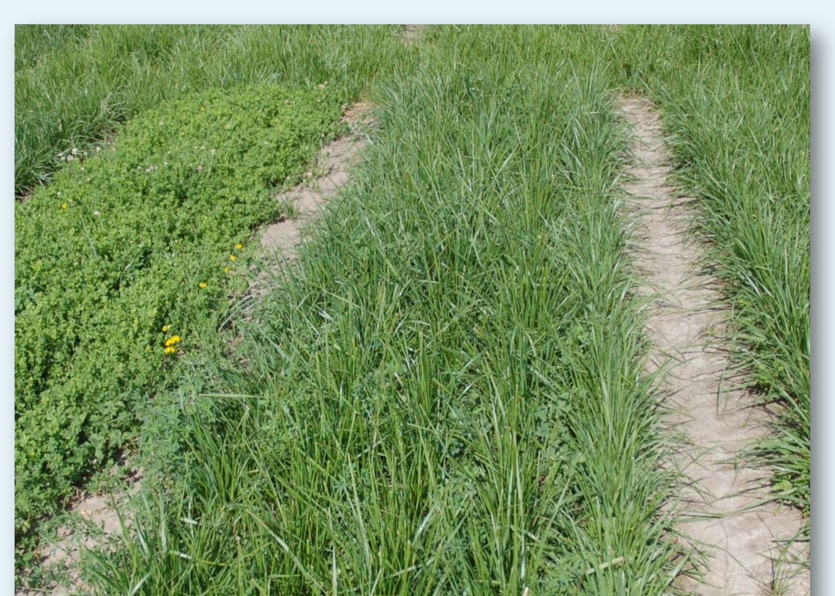
[1]TF–NF = tall fescue without N fertilizer; TF+NF = tall fescue with N fertilizer; TF+ALF = mixture (50:50 on an as-fed basis) of tall fescue (without N fertilizer) and alfalfa; and TF+BFT = mixture (50:50 on an as-fed basis) of tall fescue (without N fertilizer) and birdsfoot trefoil. [2]Ether extract. [3]Non-fibrous carbohydrate = 100 – CP – NDF – EE – ash. [4]CT = condensed tannins.

Results

Table 2. Culture pH, VFA profile (m*M*), and microbial N (%) as affected by energy supplementation and pasture types.

Item	Dietary treatment[1]											
	No energy				Corn				DDGS			
	TF–NF	TF+NF	TF+ALF	TF+BFT	TF–NF	TF+NF	TF+ALF	TF+BFT	TF–NF	TF+NF	TF+ALF	TF+BFT
Culture pH	6.16^{abc}	6.08^{abc}	6.20^{abcd}	6.35^{cd}	6.07^{abc}	5.94^{a}	6.31^{bcd}	5.97^{a}	6.30^{bcd}	6.44^{d}	6.43^{d}	6.02^{ab}
Total VFA	36.3^{bcd}	44.7^{f}	36.9^{cd}	36.0^{bc}	39.6^{e}	45.3^{f}	37.7^{d}	39.2^{e}	36.0^{bc}	44.7^{f}	35.4^{b}	32.9^{a}
C2	22.8^{de}	26.6^{f}	23.5^{e}	22.8^{de}	23.6^{e}	20.7^{b}	22.1^{cd}	22.4^{d}	21.0^{b}	27.1^{f}	21.2^{bc}	18.8^{a}
C3	7.74^{abc}	9.92^{d}	7.42^{ab}	7.32^{a}	7.78^{abc}	11.5^{e}	7.76^{abc}	8.33^{c}	8.20^{bc}	9.69^{d}	7.63^{abc}	7.75^{abc}
C4	4.00^{ab}	5.29^{e}	3.82^{a}	3.80^{a}	5.32^{e}	9.13^{f}	5.47^{e}	5.47^{e}	4.84^{d}	5.37^{e}	4.55^{cd}	4.37^{bc}
Valerate	0.64^{a}	1.18^{e}	0.63^{a}	0.69^{ab}	0.74^{b}	1.85^{f}	0.71^{ab}	1.01^{d}	0.78^{b}	0.90^{c}	0.73^{b}	0.77^{b}
Isobutyrate	0.52^{cde}	0.60^{g}	0.54^{ef}	0.52^{cde}	0.51^{bcd}	0.54^{ef}	0.57^{fg}	0.43^{a}	0.46^{ab}	0.49^{bcd}	0.53^{def}	0.48^{bc}
Isovalerate	0.67^{a}	0.95^{c}	0.78^{ab}	0.80^{abc}	1.44^{d}	1.42^{d}	0.88^{bc}	1.37^{d}	0.66^{a}	0.85^{bc}	0.68^{a}	0.65^{a}
C2:C3	2.95^{de}	2.68^{bcd}	3.17^{e}	3.11^{e}	3.10^{e}	1.81^{a}	2.85^{cde}	2.73^{bcd}	2.56^{bc}	2.80^{cde}	2.78^{cd}	2.43^{b}
Microbial N	7.85^{ab}	8.13^{bcd}	7.78^{a}	8.41^{cde}	8.00^{abc}	8.85^{ef}	9.34^{f}	8.59^{de}	8.56^{de}	8.34^{bcd}	9.12^{f}	8.44^{cde}

[1]TF–NF = tall fescue without N fertilizer; TF+NF = tall fescue with N fertilizer; TF+ALF = mixture (50:50 on an as-fed basis) of tall fescue (without N fertilizer) and alfalfa; and TF+BFT = mixture (50:50 on an as-fed basis) of tall fescue (without N fertilizer) and birdsfoot trefoil.



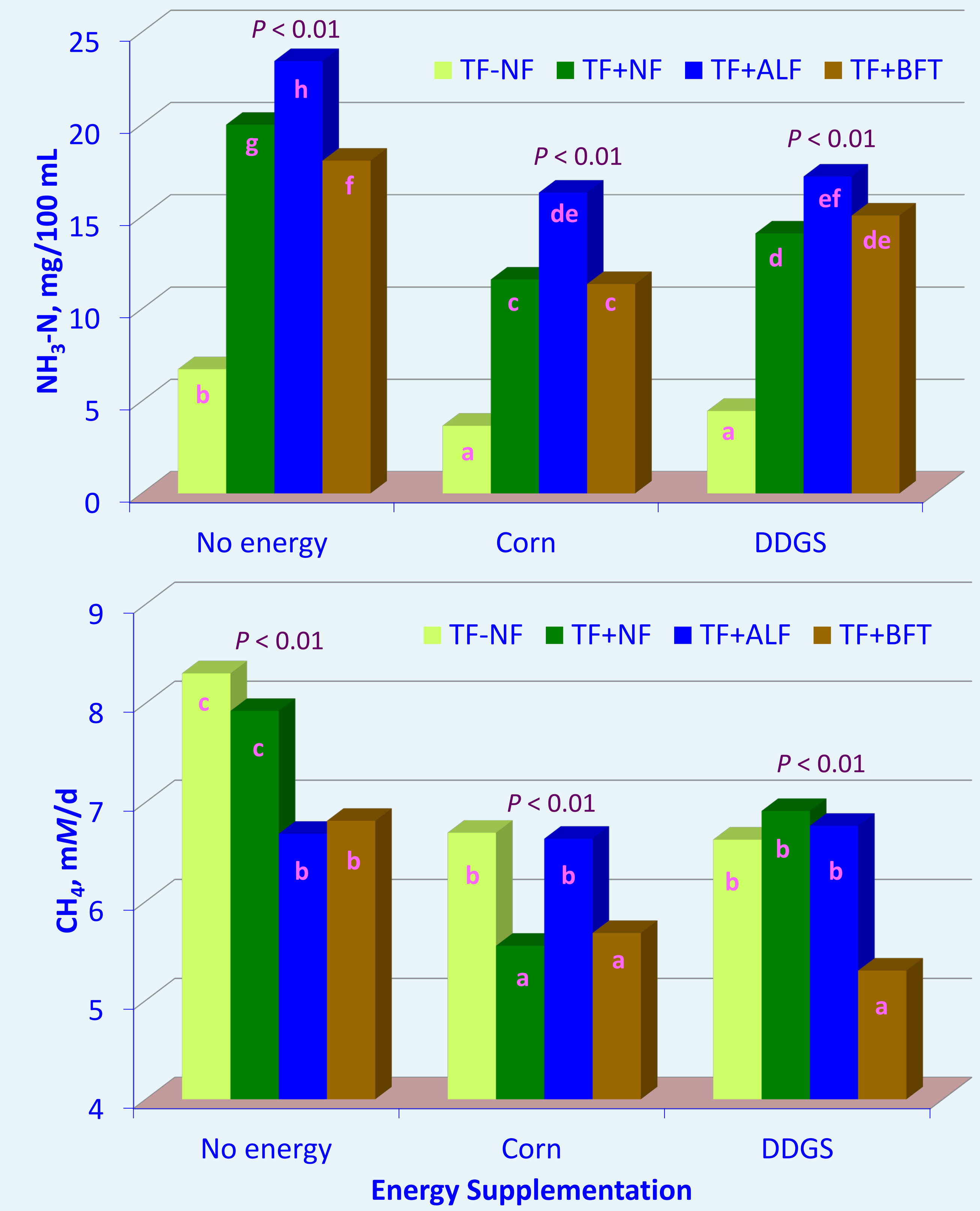


Figure 1. Ammonia-N concentration and methane production as affected by energy supplementation and pasture types.

Summary & Conclusions

- **Both corn and DDGS supplementation increased N utilization by decreasing NH_3-N and increasing microbial protein yield.**
- **Energy supplementation decreased A:P, and under corn supplementation the TF+NF and the TF+BFT decreased A:P compared with the TF–NF.**
- **The TF+BFT decreased CH_4 production, and the effect was more noticeable when the TF+BFT was supplemented with corn or DDGS.**
- **The TF+BFT showed similar N utilization compared with the TF+NF, implying that BFT mixed with TF can eliminate N fertilization to TF.**
- **Grass-legume mixtures would be a sustainable component in grazing dairy systems to improve N utilization efficiency with appropriate energy supplementation.**

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