

Development of New Alfalfa Products in Combination with Almond Hulls for emerging Domestic and International Markets

Katherine Swanson, Maia Zack, Ed DePeters, and Dan Putnam

University of California, Davis



Objective:

To measure the forage quality characteristics and digestibility of various combinations of alfalfa-almond hull mixtures in cubes utilizing laboratory techniques and sheep studies to develop innovative products centered upon alfalfa.

Experimental Approaches:

- Samples of almond hulls (AH) and four qualities of alfalfa (low, low/medium, medium, and high) were obtained and mixed so that AH were at 0, 25, 50, or 75%. There was also one pure AH sample, which resulted in 17 total samples used for *in vitro* and composition analysis.
- Fermentation rate and extent using the syringe gas method were determined for all 17 samples in triplicate over 3 independent runs. The data were analyzed using a nonlinear mixed effects model. Values from 24-hour gas production were used to calculate metabolizable energy.
- The samples were also used for the Ankom DAISY *in vitro* method for 12, 24, 30, and 48 hour incubations. There were three *in vitro* runs, and all samples were run in triplicate over 3 independent runs. *In vitro* data were analyzed using a mixed effects model.
- Pure low/medium quality (about 53% TDN on 90% DM basis) alfalfa hay was used, along with mixes containing 10, 20, or 40% AH, in a sheep digestibility study, where the alfalfa and mixes were all cubed. Eight sheep (wethers) were fed the three unique diets as well as a pure AL control diet in a replicated 4x4 Latin square design study, allowing for each sheep to eat each diet.
- During the last 7 days of each period, sheep were fitted with a fecal-collection harness to allow for total collection of feces to determine apparent digestibility. Fecal samples were mixed, dried, and sent with feed samples of each treatment to Cumberland Valley Analytical Services for composition analysis. Data were analyzed using R version and a linear mixed effects model.



Table 1. *In vitro* gas production at 24 hours, calculated ME, Daisy dry matter digestibility at 24 hours, and Daisy neutral detergent fiber digestibility at 24 hours for all alfalfa and AH mixes.

Alfalfa Quality	AH %	24hr ml/g gas	ME (MJ/kg)	Daisy DMD 24hr	Daisy NDFD 24hr
None	100	294.8	10.5	67.0	26.8
	75	277.3	10.4	62.4	32.5
	50	271.9	10.6	57.0	29.8
	25	262.5	10.8	56.5	37.7
High	0	240.5	10.5	56.4	37.4
	75	283.8	10.5	60.6	27.3
	50	268.2	10.2	54.1	25.6
	25	243.7	9.9	51.6	28.7
Medium	0	231.8	9.8	49.1	32.6
	75	280.0	10.3	64.4	31.0
	50	266.2	10.3	56.2	23.1
	25	240.0	9.7	53.6	32.4
Low/ Medium	0	224.4	9.6	52.1	29.4
	75	268.8	9.9	61.2	22.3
	50	246.9	9.4	52.9	15.2
	25	225.5	9.0	49.6	25.0
Low	0	195.9	8.3	44.4	26.9

Table 2. Sheep digestibility of low/medium quality alfalfa cubed with 0, 10, 20, or 40% almond hulls.

	0% AH	10% AH	20% AH	40% AH	SE
% Digestibility					
DM	59.5 ^a	62.9 ^b	61.7 ^b	61.3 ^b	0.65
OM	60.9 ^a	64.1 ^b	62.3 ^a	61.5 ^a	0.66
CP	70.8 ^a	72.1 ^a	67.6 ^b	55.6 ^c	0.83
ADFom	45.8 ^a	43.0 ^a	39.1 ^b	34.8 ^c	1.13
NDFom	44.7 ^a	42.8 ^a	38.9 ^b	36.6 ^b	1.38

^{a-c} Different lettered superscripts denote significant differences in averages ($p < 0.05$) for each nutritional component.

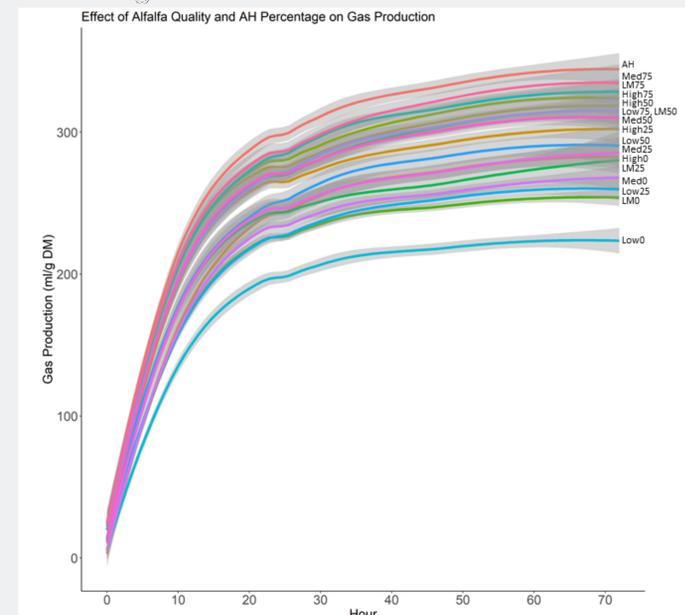
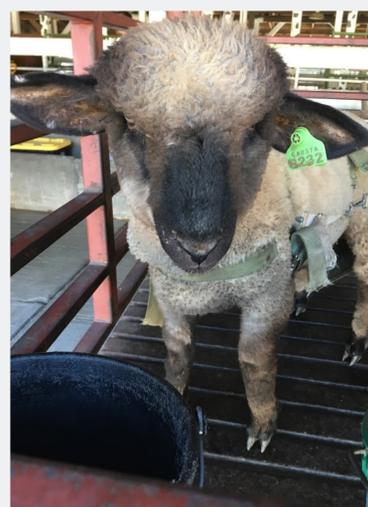


Figure 1. *In vitro* gas production (ml/g of DM sample) for all 17 samples over 72 hours, averaged over 3 independent runs.

Results:

- The alfalfa samples ranged from 45 to 58 TDN while the AH had a high TDN but only 5.6% crude protein. For all mixes, as the amount of AH increased, the calculated TDN and non-fiber carbohydrates (NFC) increased while percent crude protein and neutral detergent fiber decreased.
- *In vitro* results (Table 1 and Figure 1) showed that the Low/Medium quality alfalfa mixed with 25 or 75% AH had improved dry matter and NDF digestibility, and the Low/Medium with 50 or 75% AH had calculated metabolizable energy values that were comparable to that of the pure High quality alfalfa.
- In sheep (Table 2), a diet consisting of Low/Medium quality alfalfa cubed with 10% AH was found to have the highest dry matter, organic matter, and crude protein digestibilities with only small decreases in ADF and NDF digestibilities compared to the 0% AH diet.

Conclusions:

Overall this research suggest that mixing low amounts of almond hulls with low to medium (e.g. 38-48% NDF) quality alfalfa hay could be beneficial by increasing the overall dry matter and crude protein digestibility with only slight decreases in fiber digestibility.

Acknowledgements

We thank the National Alfalfa and Forage Alliance checkoff program for funding this project and giving us an opportunity to conduct valuable research. We also thank the Almond Board of California for their generous donation of almond hull samples.