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

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RATIONALE & OBJECTIVES

- Alfalfa growers have indicated a strong interest in 'value-added' products which could enhance the value of their crop and create new markets. Large quantities of high-energy fleshy almond hulls as a by-product of almond production are available in California.
- Could different combinations of alfalfa and almond hulls produce 'synergy' when used in combination, enabling new products for alfalfa growers?

Objectives:

To measure the potential quality of combination of alfalfa/almond hulls through lab and sheep feeding trials to explore new markets.

RESEARCH DESCRIPTION *(2 studies conducted)*

Study 1:

Laboratory *in vitro* quality analysis. Ground samples of low, low/medium, medium, and high-quality alfalfa hay were combined with almond hulls at ratios of 100:0, 75:25, 50:50, 25:75% and 0:100% alfalfa: almond hull mixtures. Samples were analyzed for forage quality (chemical analysis) and *in vitro* digestibility utilizing both gas production over 72 hours and Daisy Dry Matter Digestibility (DMD) and Neutral Detergent Fiber digestibility (NDFD) at 12, 24, 30, and 48 hours of fermentation. Gas production (24 hours) was used to calculate Metabolizable Energy (ME).

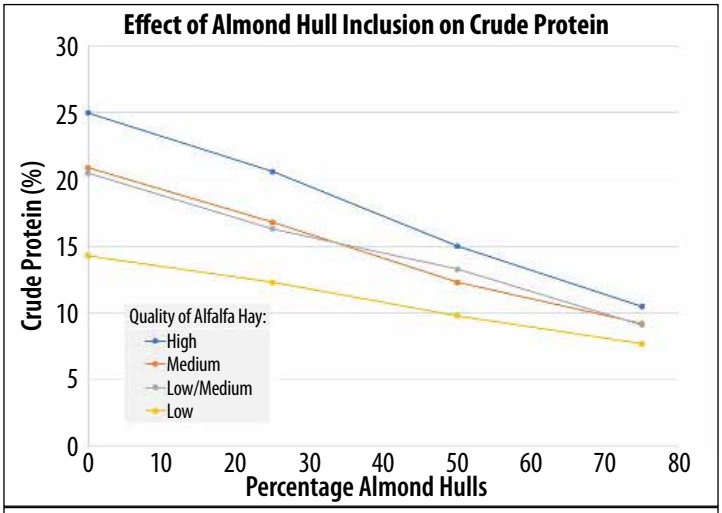
Study 2:

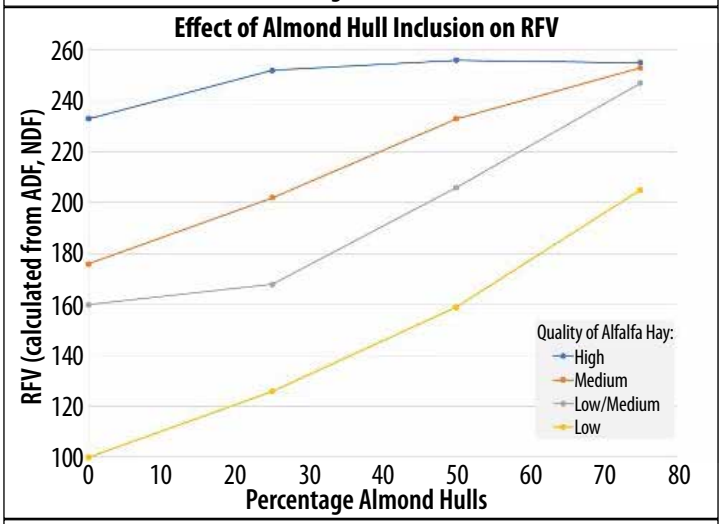
Sheep Feeding Study. Cubes were manufactured with 0, 10, 20, and 40% almond hulls (alfalfa-almond hulls 100:0, 90:10, 80:20, and 60:40) with a low-medium alfalfa hay and fed to eight sheep in a replicated 4x4 Latin Square digestion trial. Fecal collection harnesses were used, and cubes and feces were analyzed for chemical composition to determine apparent digestibility.

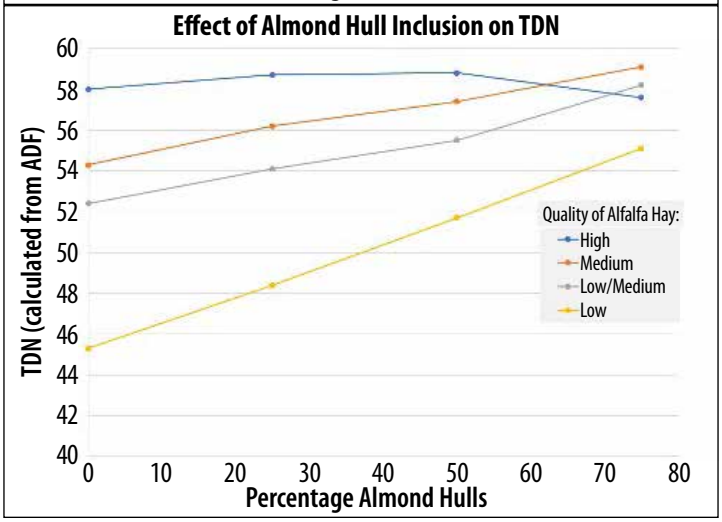
RESULTS

- Inclusion of almond hulls with alfalfa hay reduced the Crude Protein (CP), NDF, and Acid Detergent Fiber (ADF) of the sample mixes, resulting in higher Relative Feed Value (RFV) and Total Digestible Nutrients (TDN) but lower CP in the mixes (Figure 1).

Figure 1. Effect of four initial qualities of alfalfa mixed with varying amounts of almond hulls on CP, RFV, and TDN. For reference, almond hulls had 5.6% CP, 20.9% NDF, 22.9% NDF, 7.1% lignin, 299 RFV, and 60.1% TDN (90% DM), and 64.3% Non-Fiber Carbohydrates (NFC).







- Inclusion of almond hulls improved DMD, gas production, and estimated ME concentration in the lower-quality hays more than the high-quality hay, where there was a less benefit of adding almond hulls to the alfalfa (Table 1).
- Fiber digestibility (NDFD) was lower in the pure almond hulls, and inclusion of the hulls with alfalfa hay generally did not improve fiber digestibility (Table 1). Almond hulls are higher in lignin as a percentage of the NDF.
- Modest inclusion of almond hulls (10%) improved dry matter, organic matter, and CP digestibility in sheep (Table 2). Almond hulls were lower in fiber digestibility, but improved energy and DM digestibility in the mixes.

CONCLUSIONS

These data suggest that there are potential benefits forage quality and for *in vitro* and *in vivo* digestibility when low amounts (e.g., 10-20%) of almond hulls are mixed with low/medium quality alfalfa, but not higher qualities of alfalfa hay. Mixing alfalfa hay with almond hulls lowers NDF and ADF concentrations improved RFV and TDN and ME values, which may be of interest for marketers and nutritionists. There are major cost differences between alfalfa hay and almond hulls that may be to the advantage of buyer and seller. The *in situ* sheep study showed increases in Dry Matter and Organic Matter digestibility, but reductions in NDFD, suggesting that the fiber in almond hulls is less digestible due to relatively higher lignin content.

Table 1. *In vitro* gas production, ME, DMD at 24 hours, and NDFD at 24 hours for all alfalfa and almond hull mixtures. Initial Quality was based upon NDF, ADF, and CP Levels.

Alfalfa Quality*	Almond Hulls %	24-hr gas Production ml/g	ME MJ/kg	DMD 24hr %	NDFD 24hr %
None (Almond Hulls)	100	294.8	10.5	67.0	26.8
High	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
	0	240.5	10.5	56.4	37.4
Medium	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
	0	231.8	9.8	49.1	32.6
Low/Medium	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
	0	224.4	9.6	52.1	29.4
Low	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
	0	195.9	8.3	44.4	26.9

Table 2. Sheep digestibility of dry matter (DM), organic matter (OM), CP, ADFom, NDFom for low/medium quality alfalfa cubed with 0, 10, 20, or 40% almond hulls.

	0% Almond Hulls	10% Almond Hulls	20% Almond Hulls	40% Almond Hulls	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 between treatments ($p<0.05$) for each nutritional component.

Alfalfa U.S. Alfalfa Farmer Research Initiative

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