

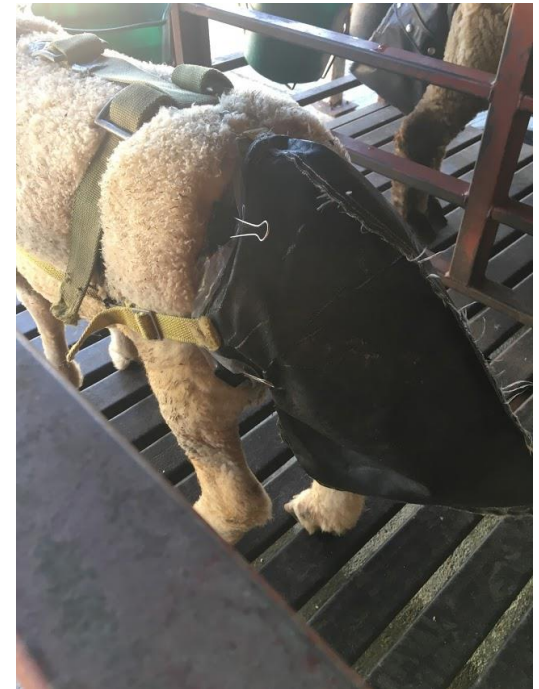
Development of New Alfalfa Products in Combination with Almond Hulls for emerging Domestic and International Markets

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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.

Mixes of 4 qualities of alfalfa with 0, 25, 50, 75, or 100% almond hulls



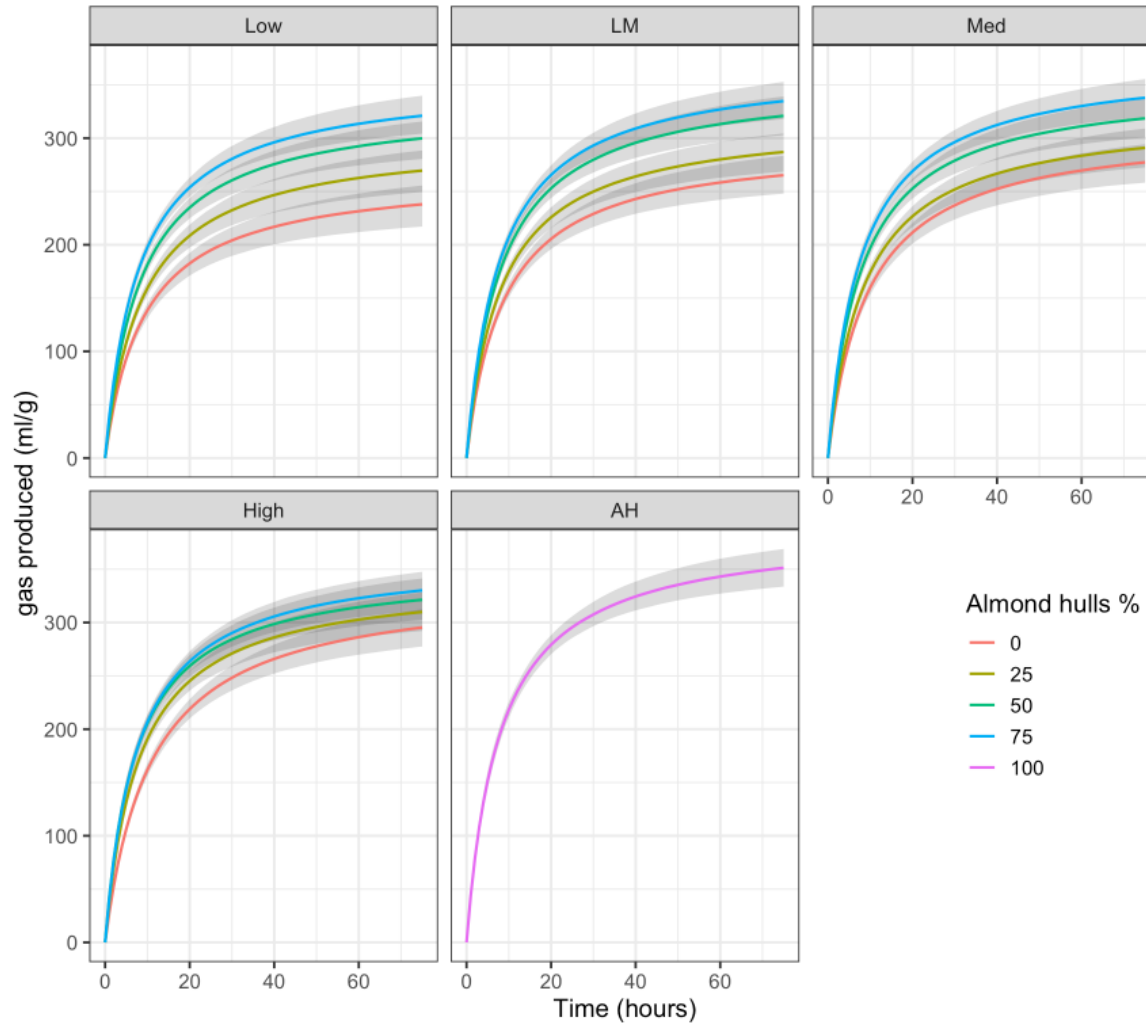
Daisy Results

| Alfalfa | Almond Hulls | Hours of Incubation | | | |
|---------|--------------|---------------------|------|-------------------|------|
| | | 24 | 30 | 24 | 30 |
| | | DM digestibility | | NDF digestibility | |
| Low | 0 | 44.4 | 41.9 | 26.9 | 28.5 |
| | 25 | 49.6 | 46.3 | 25.0 | 24.3 |
| | 50 | 52.9 | 52.6 | 15.2 | 22.1 |
| | 75 | 61.2 | 58.4 | 22.3 | 25.0 |
| Low/Med | 0 | 52.1 | 50.0 | 29.4 | 31.3 |
| | 25 | 53.6 | 51.5 | 32.4 | 36.9 |
| | 50 | 56.2 | 55.0 | 23.1 | 30.9 |
| | 75 | 64.4 | 62.4 | 31.0 | 31.5 |
| Med | 0 | 49.1 | 49.7 | 32.6 | 34.3 |
| | 25 | 51.6 | 52.2 | 28.7 | 31.3 |
| | 50 | 54.1 | 56.9 | 25.6 | 28.8 |
| | 75 | 60.6 | 63.5 | 27.3 | 31.8 |
| High | 0 | 56.4 | 59.2 | 37.4 | 34.4 |
| | 25 | 56.5 | 58.3 | 37.7 | 32.7 |
| | 50 | 57.0 | 58.8 | 29.8 | 28.9 |
| | 75 | 62.4 | 61.2 | 32.5 | 25.7 |

- LM and Med alfalfa with 25-50% almond hulls were comparable to High quality alfalfa for Dry Matter Digestibility
- Almond hulls generally decreased NDF digestibility

Gas Fermentation Results

Figure 1.38: Estimated gas production curves with 95% confidence limits for the MM model. The range of hours is limited to a max of 20 to expand the rapid fermentation phase.



Gas Fermentation Results

| Alfalfa | Almond | | Vm (ml/g) | SE | r (ml/g/h) | SE |
|---------|--------|--|-----------|------|------------|------|
| | Hull % | | | | | |
| Low | 0 | | 267 | 12.7 | 15.4 | 0.41 |
| | 25 | | 302 | 13 | 17.8 | 0.44 |
| | 50 | | 333 | 12.6 | 20.3 | 0.39 |
| | 75 | | 356 | 12.6 | 22.2 | 0.39 |
| Low/Med | 0 | | 297 | 12.7 | 17.6 | 0.41 |
| | 25 | | 318 | 12.6 | 19.6 | 0.4 |
| | 50 | | 356 | 12.6 | 22.1 | 0.39 |
| | 75 | | 370 | 12.6 | 23.4 | 0.39 |
| Med | 0 | | 312 | 12.7 | 17.8 | 0.41 |
| | 25 | | 325 | 12.6 | 19.5 | 0.4 |
| | 50 | | 352 | 12.6 | 22.2 | 0.39 |
| | 75 | | 373 | 12.7 | 23.7 | 0.41 |
| High | 0 | | 339 | 12.7 | 17.9 | 0.41 |
| | 25 | | 343 | 12.6 | 21.5 | 0.4 |
| | 50 | | 352 | 12.7 | 23.2 | 0.41 |
| | 75 | | 364 | 12.6 | 23.4 | 0.39 |
| AH | 100 | | 388 | 12.6 | 24.6 | 0.39 |

- Almond hulls increased extent and rate of fermentation for all alfalfa qualities
- Greatest improvement in Low quality
- With 25-50% almond hulls, the LM and Med were comparable to pure High quality alfalfa for extent of fermentation

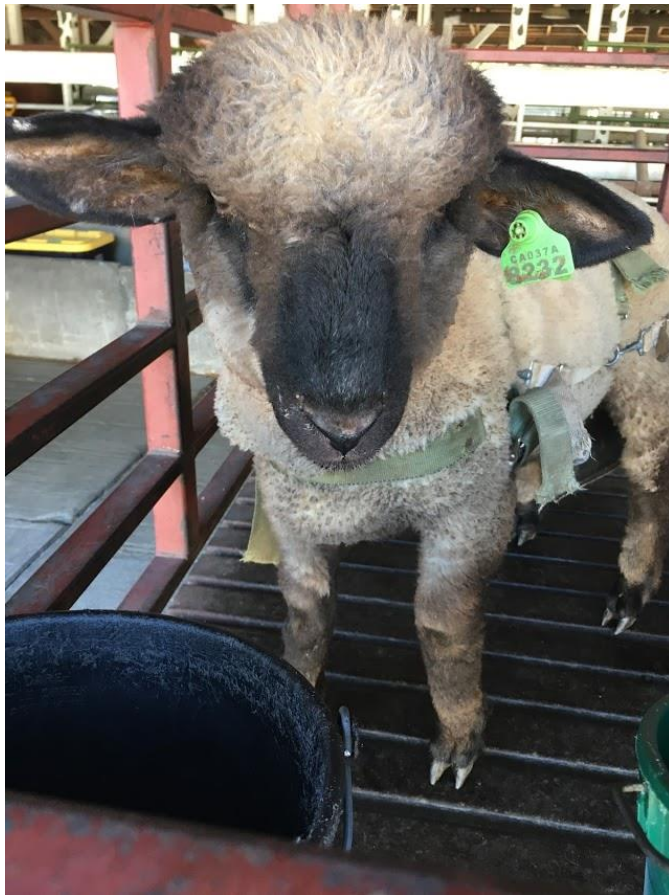
Sheep Study Results

Sheep were fed cubes of 52 TDN (~155 RFV) alfalfa 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.

Overall this research suggests 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.



Dairy Cattle Study Methods



- For this study, medium quality alfalfa (~150 RFV) was cubed with 0, 20, or 30% almond hulls. Cows were fed a total mixed ration with the cubes added in.
- Feed refusals, fecal, blood, milk, and rumen fluid samples were also collected along with weekly body weights. This was used to estimate digestibility, milk composition, ketone concentration, and volatile fatty acid concentration.

| Milk Yield and Composition | | | | |
|----------------------------|------|-------|-------|------|
| % AH | 0% | 20% | 30% | SE |
| Yield (kg/day) | | | | |
| Milk | 46.0 | 45.7 | 45.1 | 2.37 |
| ECM | 46.4 | 47.5 | 46.7 | 1.76 |
| Fat | 1.51 | 1.60 | 1.58 | 0.06 |
| Protein | 1.54 | 1.55 | 1.51 | 0.07 |
| Lactose | 2.34 | 2.31 | 2.27 | 0.13 |
| Composition % | | | | |
| Fat | 3.31 | 3.55* | 3.48 | 0.19 |
| Protein | 3.37 | 3.40 | 3.35 | 0.07 |
| Lactose | 5.07 | 5.05 | 5.05 | 0.05 |
| MUN | 8.95 | 8.76 | 9.94* | 0.29 |
| SCC | 19.4 | 19.8 | 24.8 | 6.5 |

Overall

- Cows consumed the most CP, NDF, and ADF while on the 20% AH cube diet, but had the lowest digestibilities for those components and spent the most time ruminating.
- The milk fat percentage was highest for the cows consuming the 20% AH cube diet as was the molar percentage of butyrate produced.
- This research suggests that mixing low amounts of almond hulls (~10%) with medium (e.g. 38% NDF) quality alfalfa hay could be beneficial by increasing the milk fat composition and yield of high producing dairy cows compared with cows consuming no almond hulls and medium quality hay.
- Potential to improve value of fair or good quality alfalfa by \$10-35/ton with addition of cheaper almond hulls at 10%

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