Are There Unique Features of Alfalfa Hay in a Dairy Ration?

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Is There Magic in Alfalfa Hay?

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Some Background

- Alfalfa has always been part of the CA dairy industry. Would the industry have been as successful without alfalfa?
- 1997 -> 1.0 million lactating cows
- 2008 -> 1.7 million lactating cows
- Now -> 2.0 (?) million lactating cows, but no growth
  - Alfalfa acreage flat since about 1980
  - Imports from other states limited by costs
  - Dairy economics went in the toilet in early 2009
  - Alfalfa hay prices soared
% Inclusion of forages in high group dairy rations
Morphology of alfalfa showing ranges in digestibility of the respective plant parts.

USDA drawing (modified by Van Soest)
Alfalfa Hay
--- > Nutritionists’ Inside View

- **ASH (minerals and dirt)**: 7 - 15%
- **FATS**: 2 - 3%
- **PROTEINS (soluble, bound, degradability, amino acids)**: 15 - 26%
- **NON-STRUCTURAL CARBOHYDRATE (NSC -> sugars, starch, pectin)**: 19 - 33%
- **STRUCTURAL CARBOHYDRATE (NDF -> cellulose, hemicellulose, lignin, cutin)**: 25 - 55%
Structural carbohydrates (NDF)

- **Neutral detergent fiber (NDF)**
  - all structural carbohydrates
    - cellulose, hemicellulose, lignin, cutin

- **Acid detergent fiber (ADF)**
  - NDF minus the hemicellulose

- Cellulose and hemicellulose are digestible
- Lignin and cutin are not digestible
Key Characteristics of NDF

- **Level in high diets** - Ideal values are 28 – 34%
  - alfalfa average is ~38%
  - corn silage is ~52%
  - winter cereals are ~48%

- **Rumen fermentability** - Ideal values are High
  - alfalfa average is ~42%
  - corn silage is ~48%
  - winter cereals are ~51%

**What about ‘dead weight’ NDF** - Ideal values are Low
  - alfalfa average is ~20%
  - corn silage is ~25%
  - winter cereals are ~25%
Key Characteristics of NDF

- **Stimulation of cud chewing**
  - Very important as it reduces particle size and stimulates salivation
  - Replacement of 15% silage DM by alfalfa hay:
    - Increased cud chewing from 4.6 – 5.5 h/day
    - Increased eating time only 11 min/day

- **Cation Exchange Capacity -> CEC**
  - CEC = buffering capacity of a feed
  - High values are good
    - ‘High’ diets contain rapidly fermented carbohydrate
    - Can lead to rumen accumulation of acids
    - -> acidosis
CEC Capacity of NDF (meq/100 g NDF)

- Alfalfa hay
- Corn silage
- Wheat straw
Key Characteristics of Diet Protein

- **Level in high diets** -> *Ideal values are 16 – 17%*
  - alfalfa average is ~22%
  - corn silage is ~8%
  - winter cereals are ~11%

- **Rumen ‘solubility’** -> *Ideal values are 31 – 34%*
  - alfalfa average is ~37%
  - corn silage is ~55%
  - winter cereals are ~50%

- **Rumen ‘escape’** -> *Ideal values are 37 – 43%*
  - alfalfa average is ~32%
  - corn silage is ~34%
  - winter cereals are ~22%
Key Characteristics of Diet Protein

- Rumen ‘escape’-> *ideal values are 37 – 43%*

- Quality of rumen escape proteins
  - relates to their amino acid profiles
  - cows need amino acids (AA), not protein *per se*
    - *especially ‘essential AA’*
  - amongst many AA, there 6 or 7 nutritionally key AA
AA profiles of alfalfa hay, as well as corn and cereal silage, vs. milk protein
Non structural carbohydrates

- Starches
  - Negligible levels of starch in alfalfa hay
    - corn silage ~25% and cereal silage ~15%
  - a good source of energy, but can lead to acidosis
Non structural carbohydrates

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- **Sugars**
  - Levels vary with time of the day and speed of drying
    - alfalfa can contain up to 5% sugars
    - silages contain no sugars
Non structural carbohydrates

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- Pectins *(a.k.a. soluble fiber)*
  - Intercellular cement
  - Ferments rapidly in the cow’s rumen, *but not to lactic acid*
  - Alfalfa hay has ~10% pectin, silages have <1%
Levels of starch, sugars and pectins in alfalfa hay as well as corn and cereal silage
CEC Capacity of NDF and pectin (meq/100 g)
Ash

- Ash
  - all minerals (calcium, phosphorus etc.)
    - has nutritional value (*good ash*)
    - also contaminating soil (mainly silica)
      - no nutritional value (*bad ash*)

- Good ash
  - alfalfa average is ~6%
  - corn silage is ~3%
  - winter cereals are ~3%

- Bad ash
  - alfalfa average is ~5%
  - corn silage is ~5%
  - winter cereals are ~10%
Is Alfalfa Hay Valued Correctly?

- Dairy rations are created by nutrition professionals using relatively complex nutrient models

  - **The Problem**: Key characteristics of alfalfa hay (e.g. CEC, pectins, cud chewing) are **not** part of models

  - **The Outcome**: Ration programs consistently undervalue the true nutritional value of alfalfa hay

  - **The Good News**: Nutritional professionals know it!

  - **The Result**: Nutritional professionals ‘force’ alfalfa hay into rations even when their software says that it is not cost effective.
CONCLUSIONS

- Alfalfa hay has NDF which:
  - is close to the ideal level for high group rations
  - is relatively rapidly fermenting
    - contains lower ‘dead weight’ than corn and cereal silages
  - stimulates ruminative chewing
    - reduces particle sizes and stimulates salivation
  - has a high CEC capacity

- Alfalfa hay has protein which:
  - is higher than needed in high group rations
    - spares need for high cost protein meals
  - has a soluble fraction close to the ideal for high group rations
  - has a rumen escape fraction only slightly lower than optimal
  - has an AA profile much better than corn and cereal silages
MORE CONCLUSIONS

- Alfalfa hay has much higher pectin levels than corn and cereal silages. This is good because pectin:
  - does not lead to lactic acid production
  - is completely digested
  - has a high CEC capacity

- Alfalfa hay has:
  - twice the levels of ‘good ash’ than corn and cereal silages
  - half the bad ash level of winter cereals

- Alfalfa hay has:
  - 25% ‘dead weight’ vs. 30% in corn silage and 35% in cereal silage

When included in a high group ration at ~20% of dry matter, it increases the nutritional value of the entire ration!!
There May be Magic in Alfalfa Hay!