

DEVELOPING INNOVATIVE PROTEIN FOOD PRODUCTS FROM ALFALFA

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Introduction: Protein production for human foods will be a major challenge in the future, since we are approaching 9 to 10 billion souls on earth in the next decades – additionally per capita demand for animal protein (milk, meat) and other high protein crops (e.g. nuts) is increasing. Alfalfa is a very interesting crop for optimizing protein production per unit water or land. Alfalfa produces more protein per acre than any other crop: e.g. protein yields of 1,500 to 4,000 lbs protein/acre/year can be obtained in California. However, conversion of alfalfa to human food products has typically involved only animal conversions via milk or meat, which entails inefficiencies (typically 20-30% of the protein is converted in animal systems).

The interest here is in direct conversion of plant protein sources to human foods. There are several companies intensely interested in this concept, and we are working from the agronomic side to understand the system that would be required for this type of market. This includes genetics, harvesting schedule, handling method, plant fractionation, food safety and other important considerations. The functionality of the protein is often as important as the quantity. Alfalfa, as a perennial legume which fixes virtually all of the N needed for protein from the atmosphere, and with soil and environmental benefits, is a highly sustainable crop for this purpose. This could open up new markets for alfalfa producers.

Experimental. Over the past year to we have obtained preliminary data on this project, including a series of experiments in 2015. We estimated CP in harvests at UC Davis in 2015 that tested several agronomic aspects: leaf stripping, high cutting, maturity of crop, and season. (see Table 1). We have worked with Kevin Shinnors (USDA-ARS and UW, Madison, WI) with a leaf-stripper machine to accomplish leaf-stem separation to understand whether that would assist in improving protein concentrations. Thus far, we have concluded that:

- Yields of protein from alfalfa are very high, even if only a partial (leaf) harvest is taken. This was assessed on a single cutting basis, and 6-8 cuts are possible at Davis.
- Protein concentration of foliage can be improved to 26-35% of DM based upon leaf-stem separation or high cutting. This also aids downstream processing.
- The season and maturity of the crop has a large effect on protein concentration.

Further work is needed, and these preliminary trials did not address how agronomic practices affect the specific functionality of the soluble leaf protein. We will continue to work to improve alfalfa harvesting and handling conditions for functional protein extraction, food safety, and to devise optimal cropping systems that consider water and environmental impacts of alfalfa grown for human protein consumption. We are taking a market-driven approach, working with farmers and businesses, to which consider the whole chain, from growing the crop to harvesting conditions, handling, and product processing.

Table 1. Summary of Forage Quality, yield, protein concentration and yield of alfalfa harvested at three maturities, late summer, 2015, Davis, CA (averages of 4 replications).

Early Maturity Harvest (8/24/2015)								
Machine	Cutting Height	Plant Part	Crude Protein (%)	ADF (%)	aNDF (%)	Yield (lbs/A)	Yield (t/a)	Protein Yield (lbs/A)
Cutter Bar	high	bottom	21.2	36.2	43.9	985.9	0.5	208.2
Leaf Stripper	high	bottom	18.2	41.3	48.8	965.1	0.5	173.8
Cutter Bar	high	tops	32.9	20.3	24.1	1009.6	0.5	332.0
Leaf Stripper	high	tops	34.8	17.1	21.7	729.9	0.4	253.6
Leaf Stripper	low	bottom	17.6	42.6	50.5	728.0	0.4	128.4
Leaf Stripper	low	tops	31.2	21.8	27.7	1008.0	0.5	314.0
Cutter Bar	whole	whole	28.0	26.6	32.0	1971.0	1.0	551.7
Mid-Maturity Harvest (8/31/2015)								
Machine	Cutting Height	Plant Part	Crude Protein (%)	ADF (%)	aNDF (%)	Yield (lbs/A)	Yield (t/a)	Protein Yield (lbs/A)
Cutter Bar	high	bottom	18.5	39.8	47.6	1211.7	0.6	219.9
Leaf Stripper	high	bottom	19.4	38.6	45.4	1321.4	0.7	255.6
Cutter Bar	high	tops	29.0	24.3	28.2	1161.7	0.6	336.6
Leaf Stripper	high	tops	31.1	19.0	23.4	790.1	0.4	245.8
Leaf Stripper	low	bottom	16.6	42.9	51.1	1429.3	0.7	236.3
Leaf Stripper	low	tops	28.3	23.2	28.7	1372.8	0.7	385.5
Cutter Bar	whole	whole	24.0	31.9	37.5	2503.1	1.3	601.7
Late Maturity Harvest (9/8/2015)								
Machine	Cutting Height	Plant Part	Crude Protein (%)	ADF (%)	aNDF (%)	Yield (lbs/A)	Yield (t/a)	Protein Yield (lbs/A)
Cutter Bar	high	bottom	13.4	45.9	55.5	1334.0	0.7	178.8
Leaf Stripper	high	bottom	16.3	41.0	49.2	1222.1	0.6	200.8
Cutter Bar	high	tops	27.5	21.1	25.2	1107.9	0.6	304.5
Leaf Stripper	high	tops	23.7	27.2	32.0	2112.3	1.1	502.6
Leaf Stripper	low	bottom	13.5	47.0	56.5	1144.1	0.6	154.9
Leaf Stripper	low	tops	22.8	29.0	34.9	1541.9	0.8	352.2
Cutter Bar	whole	whole	20.2	34.8	41.2	3238.6	1.6	645.2