

BIOAG PROJECT FINAL REPORT

TITLE: Developing research and production information to evaluate Camelina and Canola in a sustainable cropping, bio-fuel processing and livestock feeding system.

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KEY WORDS: Camelina, Canola, protein supplements, cattle

ABSTRACT: Our integrated project will conduct a nutritional analysis of the biodiesel byproduct, and complete an economic analysis using Camelina and Canola byproducts as ruminant feed. The studies contained in this proposal address several of the 2012 BioAg priority areas: Innovation and diversification of intensive and biologically sound cropping systems using alternative oilseed crops to buffer economic stresses by maintaining a greater proportion of crop income at the farm level; to assist in adding stability to volatile energy markets by providing substrate for biofuel geared toward national energy independence; provide information that is critical in utilization of canola and camelina meals in ruminant diets and thereby promoting livestock health and well-being; and to expand the body of knowledge relevant to oilseed byproducts and their use.

PROJECT DESCRIPTION: ***Heifer Feeding Study (Start Date = November 23, 2012; Status--Complete)***

In the fall and winter of 2012/2013, crossbred beef replacement heifers (n = 37; age = ~ 9 months at initiation of study; body weight [BW] = 290 ± 22 kg) were utilized to compare the Canola meal and Camelina meal with soybean meal (a traditional protein supplement).

TREATMENTS:

1. Control (base forage of wheat straw/alfalfa hay)
2. Camelina meal (37.1% CP [Dry matter, DM basis] fed at 0.19% of BW)
3. Canola meal (27.8% CP [DM basis] fed at 0.25% of BW)
4. Soybean meal (51.6% CP [DM basis] fed at 0.14% of BW)

MEASUREMENTS:

- Oilseed meals fed to provide equal amounts of protein to the heifers' diets. Heifers individually fed 3 days/week with the amount fed prorated to deliver the desired daily allotment.
- BW data were collected on day 1 and BW and average daily gain (ADG) data collected at days ~ 45 and 90, and pregnancy data was recorded at the end of the 2013 grazing season.

RESULTS:

- For cumulative BW change, no differences ($P = 0.89$) were noted between the all forage control (CTRL; alfalfa hay and wheat straw) and the on-farm processed products (on-farm processed Canola and Camelina meal grouped together).

- The feeding of Canola meal resulted in a 36% greater ($P = 0.04$) cumulative BW change when compared with Camelina meal. The same trends were apparent when comparing the oilseed meals based on the heifers responses in ADG.
- No significant differences were observed between the CTRL and the oilseed meals. However, as ADG was again 36% greater ($P = 0.04$) for Canola meal compared to Camelina meal.

Results also indicate some palatability issues with Camelina meal. This, as far as we know, has not been previously reported in the scientific literature. Previous research utilized Camelina meal in a mixed ration and therefore was not easy for the cattle to sort the feed. In our study, the protein supplements were fed separately, giving clear evidence of palatability differences among the oilseed meals. In our study, we fed Camelina meal as a protein supplement separately from the base forage and therefore any palatability issues may not have been masked as is possible in a mixed ration.

- Conclusions: In total, the results indicate that good performance can be obtained by using Canola meal as a protein supplement in beef heifer diets. There was no difference between Canola meal and soybean meal. However, Canola meal has a definite advantage over Camelina meal, which may be due in part to some palatability issues observed with Camelina meal.

Digestion Study (In Situ; Start Date = December 10, 2012; Status--Complete)

All activities in our experimentation utilizing research animals were conducted in accordance with an approved protocol of the Washington State University Institutional Animal Care and Use Committee.

The objective of our study was to evaluate *in situ* degradation of on-farm and commercially processed oilseed meals, and common forages found in the PNW to provide information as to how the oilseed meals potentially fit as protein supplements for beef and dairy cattle. Bio-fuel byproduct oilseed meals (i.e. Canola and Camelina meal) have the potential to supply the supplemental nutrients required by grazing beef cattle at a lower cost than traditional protein supplements such as alfalfa hay and soybean meal.

The degradation (digestion) study was conducted during the winter of 2013. Camelina and Canola were raised under dryland conditions in Eastern Washington State. Following cleaning, the seed was subjected to cold pressing. Commercially processed Canola and soybean meals were used as positive controls in the study. All oilseed meals were analyzed for dry matter (DM), nitrogen (N; for calculation of crude protein [CP]), neutral detergent fiber (NDF), acid detergent fiber (ADF), and fat. The *in situ* experiment followed a modified protocol similar to Dhanoa et al. (1999, J. Anim. Sci. 77:3385-3391) and Olaisen et al. (2003, J. Anim. Sci. 81:520-528). Briefly, one Holstein steer on an alfalfa-based diet (CP = 19.3%; NDF = 38.3%; DM basis) was fitted with a rumen cannula to serve as the fermenter in the *in situ* experiment. Oilseed meals were ground to pass a 2-mm screen and placed in Dacron bags ($50 \pm 3 \mu\text{m}$ pore size) and heat sealed (sample size = 10 g). The bags were placed in rumen tubes and inserted into the rumen for 4, 8, 24, 48, and 96 h. The tubes for each incubation cycle were inserted below the rumen mat and by descending time. All digestion tubes for an incubation cycle were withdrawn from the rumen at one time. The experiment was replicated four times.

Software was developed to easily manage the data and mathematical modeling of the digestion data analysis. In addition to generating information about the oilseed meals digestion kinetics, a method was developed to account for zero hour bag washout of particulate forage material and to include these particulates in the correct digestion fraction. Two methods of post-rumen digestion bag washes (i.e. neutral detergent fiber [NDF] and Bar Diamond Fiber [BDF]) were compared based

on their ability to remove rumen microbial contamination after exposure to the rumen environment. The thought process behind the NDF and BDF bag washes is to lower the cost of sample analysis as well as finding which method allows for the most accurate estimate of rumen digestibility.

MEASUREMENTS:

- Rates and extent of digestion for DM, OM, NDF, and CP of farm-processed Canola and Camelina meals; and commercially processed Canola and Soybean Meals. In addition, alfalfa hay (the basal diet) was evaluated for the same forage quality characteristics.

RESULTS AND CONCLUSIONS

- THE CHEMICAL COMPOSITION OF THE OILSEED MEALS EVALUATED IS PRESENTED IN TABLE 1.

Table 1. Chemical composition of oilseed meals (% of DM)

Item ²	Oilseed Meals ¹			
	CanolaFP	CanolaM	CamelinaFP	SBM
DM	92.9	89.9	93.6	88.3
CP	25.9	39.2	37.4	50.3
NDF	33.8	25.5	22.9	19.5
ADF	25.7	18.8	19.0	8.8
NFC	15.9	25.4	44.0	23.1
EE	19.3	2.9	12.3	1.0
ADL	9.3	8.0	5.8	1.0

¹CanolaFP = farm processed Canola meal; CanolaM = commercially processed Canola meal; CamelinaFP = farm processed Camelina meal; SBM = commercially processed soybean meal.

² DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; NFC = non-fiber carbohydrate; EE = ether extract (fat); ADL = acid detergent lignin.

- On-farm processed Canola and Camelina meals contain adequate protein to be suitable for protein supplements, but also contain significant amounts of fat when compared to the commercially processed oilseed meals. Results also indicate that DM and CP rumen digestibility of on-farm processed Canola meal and commercially processed Canola meal is less than expected. Camelina had the lowest extent of digestion. The digestibility of soybean meal is consistent with previous tabular values.
- Preliminary results indicate that residual mucilage in Camelina meal may cause abnormalities in the extent of degradation in the rumen. This mucilage may also explain some of the palatability issues observed with Camelina meal in the heifer feeding study. A significant amount of seed coat mucilage was present in the Camelina meal which is likely responsible for the depression in DM and CP digestibility.
- The fat content of the on-farm processed oilseed meals must be taken into account when feeding them to cattle as protein supplements. While the high-fat levels provide more energy to the animals, it is possible that the additional fat may depress forage digestion and utilization due to physical or chemical barriers to the rumen microbes.

- The aforementioned point is especially important to note when farmers and ranchers don't feed their protein supplement every day to take advantage of the ruminants' ability to recycle nitrogen. In this scenario, a week's allotment of protein supplement may be prorated and fed in two to five days. In doing so the additional fat may actually reduce forage utilization and animal performance.
- Discussions at the 2014 Washington Biofuels Cropping Systems annual meeting suggest that seed coat mucilage has been a concern since researchers began working with Camelina.
- Based on the results of the *in situ* study, there is evidence that the BDF wash may be more appropriate for measuring the rate and extent of digestion of CP than the traditional NDF.
- We developed a technique to account for the 0 hour bag washout to more accurately estimate the rate and extent of digestion of the feeds.

OUTPUTS

- Heifer feeding study complete. Data analyzed.
- *In situ* degradation (digestion) study complete. Preliminary data available, final data in analysis.
- **Based on results, additional experimentation:** *In situ* methods study. This study is a subset of the *in situ* degradation study. It was designed to validate our new BDF wash method (for the elimination of microbial contamination) and therefore reduce the cost and increase the ease of *in situ* experiments while maintaining the accuracy of results when compare to traditional NDF washes. Preliminary data available, final data in analysis.
- **Based on results, additional experimentation:** Chemical treatment of oilseed meals to remove seed coat mucilage and enhance digestion by ruminants.
- PUBLICATIONS, HANDOUTS, OTHER TEXT & WEB PRODUCTS: Please see attached documents.
 - In cooperation with Dr. Shannon Neibergs and assistants, a protein supplement selection decision aid has been developed based on the chemical analysis of the oilseed meals that were included in this study, and will be submitted to the WSU Fast Track system for publication to assist livestock producers in selecting cost-effective protein supplements for their herds.
 - Posters
 - Evaluating Camelina and Canola meals for livestock feeding systems
 - Evaluating Camelina and Canola meals as protein supplements for beef heifers
 - Chemical composition and *in situ* degradability of on-farm processed Canola and Camelina meals
 - Beef cattle winter feed and protein supplement cost calculator
 - Publications (in preparation)
 - Winter feed and protein supplement cost calculator (WSU Extension FastTrack)
 - Chemical composition and *in situ* degradability of on-farm processed Canola and Camelina meals (Animal Feed Science and Technology)
 - Comparison of basic and neutral detergent washes for microbial correction and correction for zero time particulate loss in predicting extent of degradation in *in situ* experiments (Animal Feed Science and Technology)
 - Chemical treatment of oilseed meals to remove seed coat mucilage and enhance utilization by ruminants (working title; Animal Feed Science and Technology or Journal of Animal Science)
 - Potential additional publications (future)

- Pacific Northwest oilseed meals as protein supplements for ruminant diets (WSU Extension FastTrack)
- OUTREACH & EDUCATION ACTIVITIES:
 - Our group has presented results and other oilseed meal-related information to producers and scientists at the following activities:
 - CSANR Symposium, Pullman, WA, December 2012
 - 2013 WSU Oilseed Workshop, Kennewick, WA, January 2013
 - 2014 Oilseed and Direct Seed Conference, Kennewick, WA, January 2014
 - WSU Academic Showcase, Pullman, WA, March 2014

IMPACTS

- Short-term: Education of livestock producers on the ability of on-farm processed and commercially processed camelina and canola meals to serve as protein supplements in cattle diets. Information on their relative feeding value compared to traditional supplements will be made available. In addition, education into the economics of camelina and canola meal use in cattle diets will be presented to producers.
- Intermediate-term: Cattle producers adopt feeding practices using Camelina and Canola meals as protein supplements.
- Long-term: Adoption of the use of camelina and canola meals in cattle diets has the potential to not only affect the producers' profitability, but also may add value to the entire biofuel process. This may make it more attractive for farmers in the Pacific Northwest to include these oilseeds into their crop rotations with the added benefit of breaking crop disease cycles and increasing productivity and profitability. Biofuel processors may also increase profitability through an increased market for their byproduct meal.

ADDITIONAL FUNDING APPLIED FOR / SECURED: NA

GRADUATE STUDENTS FUNDED: NA

RECOMMENDATIONS FOR FUTURE RESEARCH:

Utilization Study (in vivo)

Based on the data generated in the *in situ* work, a cattle feeding study (measuring digestion and intake) could be designed to investigate how the ruminal protein kinetics and fat digestion affect total tract and fiber digestion, and nutrient partitioning. Of particular interest is the potential to manipulate diets containing high fat oilseed meals to optimize both fiber and fat digestion and therefore maximize the delivery of energy to the animal.

Another area of future research is to gain a better understanding of the implications of the residual mucilage in Camelina meal affects overall whole animal digestion.