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## Graduate Student Abstracts

Interactions between the stage of maturity of *Eragrostis tef* hay and supplemental energy source on forage utilization in beef heifers.

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*Eragrostis tef* (teff) grass can be an excellent source of forage for beef cattle. However, its nutritional quality changes with advancing maturity, which could necessitate supplementation to enhance animal performance. Although grains such as corn can be used as energy supplements, their fast rate of ruminal fermentation could result in acidosis and compromise digestive function. Therefore, the use of non-forage fiber sources (NFFS), such as beet pulp, which are highly digestible has appeal in some instances. However, there is still limited information on the ideal energy supplement for beef cattle fed teff hay harvested at different stages of maturity. Therefore, our objective was to evaluate the effects of feeding teff hay harvested at either the early- (EH) or late heading (LH) stage of maturity and providing either corn grain [corn] or beet pulp pellets [BP]) as energy supplements on feed intake and rumen fermentation characteristics in beef heifers. Six ruminally-cannulated continental cross-bred beef heifers were used in a 3 × 3 split-plot design with three 21 d periods. The whole plot factor was stage of maturity of teff hay (EH or LH), and the subplot factor was type of energy supplement (no supplement/control [CON], Corn or BP). Heifers were fed once a day (0600 h) and intake was recorded daily. Corn and BP were fed at an inclusion level of 0.5% of BW and BW was measured on two consecutive days at the beginning of each period to determine the amount to feed. Supplements were offered separate from the hay at feeding and the remaining amount was introduced into the rumen via the cannula 1 h post-feeding. Rumen fluid samples were collected on d 19 (0900, 1500, and 2100 h), 20 (0300, 1200, and 1800 h), and 21 (0000 and 0600 h) to determine fermentation characteristics. In addition, rumen pH was recorded every minute, from d 14 to 21 using indwelling pH loggers. Hay intake tended ($P \leq 0.07$) to be greater for heifers fed the EH than LH hay (9.86 vs 8.58 kg); however, there was no supplement effect on hay intake ($P = 0.88$). Except for ruminal isovalerate concentration ($P \leq 0.08$), there were no stage of maturity × energy supplement interaction ($P \leq 0.90$) for all measurements. Ruminal acetate concentration tended to be greater ($P = 0.10$) for heifers fed EH than LH hay whereas butyrate concentration was greater ($P \leq 0.01$) for heifers supplemented with corn compared to CON and BP. Ruminal isobutyrate concentration tended to be lower ($P = 0.05$) and total branch-chain fatty acid concentration was lower ($P < 0.01$) for heifers supplemented with BP compared with CON and Corn. However, ruminal propionate and total VFA concentrations did not differ across diets ($P \geq 0.12$). There was no diet effect ($P > 0.05$) on mean, minimum and maximum rumen pH, or on the duration and area rumen pH was below 6.2 and 5.8. In summary, hay intake tended to be greater for heifers fed teff hay harvested at the early compared to late heading stage of maturity. In addition, despite changes in the rumen VFA profile, both stage of maturity and type of energy supplement had no detectable effect on rumen pH.

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# Feed quality and fermentation characteristics of barley and triticale grown for forage under irrigation in the Pacific Northwest

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An experiment was conducted near Moses Lake, Washington to evaluate the utility of growing spring forage barley (*Hordeum vulgare*) and triticale (*Triticale hexaploide Lart.*) in monocultures and blends to maximize yield and forage quality. We hypothesize that blending spring barley and triticale will maintain the exceptional forage yields of triticale and gain forage quality by including the barley. A field study was initiated in April of 2017 planting eight mixtures of Pronto barley and Merlin triticale at a rate of 112.1 kg/ha in a randomized complete block design with four replications: Treatment 1 - 100% Pronto; Treatment 2 - Pronto 90%/Merlin 10%; Treatment 3 - Pronto 70%/Merlin 30%; Treatment 4 - Pronto 50%/Merlin 50%; Treatment 5- Pronto 30%/Merlin 70%; Treatment 6 - Pronto 10%/Merlin 90%; Treatment 7 - 100% Merlin; and Treatment 8 - Pronto 20%/Merlin 100% (seeding rate increased to 120% of monoculture). Forage yields were determined using a forage harvester in July (harvested plots size = 0.9 meters x 4.3 meters). After harvest, the forage was further processed using a Bear Cat chopper before collection of pre-ensiled samples. Forages were packed (4.54 kg) into mini PVC research silos (four replications) and allowed to ensile for 88 days. Following ensiling, silages were extracted and subsampled for determination of dry matter recovery, forage quality, and fermentation chemistry. Treatment 6 had the highest DM forage yield of 10.67 Mg/ha but was not significantly different from other treatments except Treatment 1and Treatment 2 (8.45Mg/ha and 8.92 Mg/ha, respectively; $p < 0.05$). The fresh forage quality analysis assessed the blends potential as a hay crop. Crude protein did not differ across treatment groups, ranging from 98.5 g/kg to 108.3 g/kg. Treatments 1 and 2 had the greatest starch concentration, 72.3 g/kg and 72.0 g/kg respectively, but were not different from Treatment 3 (58.0 g/kg). Acid Detergent Fiber was highest in Treatment 6 (407.4 g/kg) but was not different from Treatment 1, 5, and 8 (389.9 g/kg, 404.4 g/kg, and 397.3 g/kg, respectively). Neutral Detergent Fiber was highest in Treatment 5 (592.0 g/kg) but was not different from Treatment 1, 3, 6, and 8 (578.2 g/kg, 584.0 g/kg, 584.3 g/kg, and 585.5 g/kg, respectively). The post-ensiled product was also analyzed for feed quality. Crude protein did not differ across treatment groups, ranging from 96.1 g/kg to 105.8 g/kg with only minimal losses in the ensiling process. Starch and fiber concentrations were affected by the ensiling process. Starch concentration was highest in Treatment 1 after ensiling (137.3 g/kg) but was not different from Treatment 1 pre-ensiled (121.8 g/kg). Treatment 2 post-ensiled starch (103.5 g/kg) was not different from Treatment 1 pre-ensiled but was higher than all other treatments ($p < 0.05$). Acid Detergent Fiber was lowest in Treatment 1 (381.5 g/kg) and Treatment 2 (322.7 g/kg). Neutral Detergent Fiber was also lowest in Treatment 1 (480.0 g/kg) and Treatment 2 (502.7 g/kg). In conclusion, blends with a higher proportion of Pronto barley have a lower fiber content and a higher starch content indicating the potential to supply greater energy per unit of feed to livestock. Blends with a higher proportion of Merlin triticale have a higher DM yield. Blending forages did not affect crude protein when harvested at mid-maturity growth. It was demonstrated that spring barley/triticale blends display good forage quality and only small differences in DM yield when compared to their respective monocultures. The forage quality is sufficient to meet the protein requirements of dry beef cows in late gestation and the measures of fiber indicate support of optimum intake and digestion. For beef and dairy producers, blending barley and triticale has the potential to supply high quality and affordable feed.

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**Title:** The effects of altering ruminal fermentable energy supply on rumen function, nutrient supply, and nitrogen utilization in finishing cattle fed diets containing distillers grains

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Because they are cost-effective compared to traditional feedstuffs, there is widespread use of corn dried distillers grains with solubles (CDDGS) in finishing cattle diets. However, as a result of its high crude protein (CP) content, dietary inclusion of CDDGS leads to nitrogen (N) intake exceeding requirements and, thus, wastage. Ruminal fermentable energy supply is a major determinant of the efficiency of N use. However, there is limited information on whether altering ruminal fermentable supply when feeding CDDGS could enhance ruminal N use efficiency, which improves production performance, and limits nitrogen (N) excretion. Therefore, the objective of this study was to examine the effects of feeding different types and amounts of grain (corn vs wheat) on ruminal fermentation characteristics and nitrogen utilization in finishing cattle fed diets containing 15% CDDGS (DM basis). Six ruminally-cannulated beef continental crossbred heifers were used a replicated 3 × 3 Latin square design with 28 d periods (first 21 d for adaptation and last 7 d for measurements). The three dietary treatments were either corn (73% of diet DM; CON), 53:20 corn/wheat blend (20W) or 33:40 corn/wheat blend (40W) as the major fermentable energy source. All diets contained 15% CDDGS (DM basis), 10% grass hay, and 1.155% mineral supplement. Heifers were also fed Melengesterol acetate (MGA) at 227 g each d. Animals were fed once daily (0700 h) and DMI was measured during the last 6 d of each period. Ruminal pH was also measured using an indwelling pH logger over the last 6 d of each period. To determine fermentation characteristics, rumen fluid was collected on d 26 (0900 h, 1500 h, 2100), 27 (0300 h, 1200 h, 1800 h) and 28 (0000 h, 0600 h) and samples were composited by cow and period. Blood samples were collected from the jugular vein 3.5 h after feeding on d 28 to determine blood glucose concentration. Data were analyzed using SAS. Dry matter intake tended to be lower ($P = 0.06$) for heifers fed the 40W compared with the CON and 20W diet. Mean and minimum pH were lower ($P \leq 0.03$) for heifers fed the 20W and 40W diets compared with heifers fed the CON diet. However, there was no diet effect ($P = 0.84$) on maximum pH. The molar proportions of acetate, propionate, butyrate, total volatile fatty acid, and branched chain fatty acid concentrations did not differ ($P \geq 0.15$) across treatments. However, heifers fed the wheat-containing diets experienced a longer duration ($P \leq 0.04$) with rumen pH less than 5.8 and 5.5; and tended ($P \leq 0.10$) to have a greater area when pH was less than 5.5. There was no diet effect ($P = 0.36$) on blood glucose concentration. In summary, increasing ruminal fermentable energy supply by feeding increasing amounts of wheat resulted in a decrease in ruminal pH that possibly led to the decrease in DMI.

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***Title:*** Bitter or Better Taste Buds? Aversion to Phenylthiocarbamide in Mature Rams

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Shrub encroachment on grasslands is a worldwide issue. Sheep are a potential tool for mitigating shrub encroachment. However, many shrubs contain bitterness attributes that serve as a mechanism to detour grazers. With human interactions limiting rangeland fire interval and little to no reduction from herbivores, these shrubs grow in size and population, thereby decreasing plant community diversity and reducing wildlife habitat. Sheep with a greater tolerance for bitter compounds would be expected to consume more bitter-tasting vegetation. We hypothesize that sheep can detect bitter-tasting compounds and the sensitivity to bitter compounds will vary from animal to animal. The objective of this study was to determine whether sheep could detect the bitter tasting compound, phenylthiocarbamide (PTC), and if so, what PTC concentration would elicit an avoidance response. Using a crossover study design, mature Rambouillet and Targhee rams (n = 30) were subjected in randomized order to various PTC concentrations mixed in the drinking water (PTC-solution). In trial 1 and 2 (n = 15/trial), 0.20, 0.56, 1.57, 4.39, and 12.39 mM and 0.20, 0.43, 0.94, 2.03, and 4.39 mM of PTC were tested, respectively. On test days, PTC-solution (trial 1: 1.5 kg; trial 2: 3.0 kg) and water (same amounts) were offered for *ad libitum* intake in a side-by-side presentation for 1 hour in trial 1 and 2 hours in trial 2. Test days were followed by a rest day where similar amounts of water and PTC-solution replaced with water were offered to limit potential carry over effects into the next test day. Consumption of PTC-solution for each PTC concentration was expressed as the percentage of PTC-solution consumed of total morning fluid intake [(PTC-solution / (PTC-solution + water without PTC)) × 100]. There was no effect ($P > 0.74$) of sequence that rams received PTC-solutions on PTC consumption during either trial. As PTC concentration increased, percentage of PTC-solution consumed decreased. The greatest decrease in percentage of PTC-solution consumed occurred between 1.57 – 4.39 mM (58%), and between 2.03 – 4.39 mM (72%) for trials 1 and 2, respectively. In trial 2, the least percentage of PTC consumed was the 4.39 mM PTC concentration that was different ($P \leq 0.05$) than all other PTC concentrations, which did not differ ($P > 0.05$) from each other in percentage consumed. For both trials, total fluid intake on rest days was not affected ($P > 0.05$) by PTC treatment or sequence from the previous test day. A high degree of variation in avoidance of PTC was observed between individuals in trials 1 ($R^2 = 0.28$) and 2 ($R^2 = 0.11$). This research suggests rams could taste the PTC, and the concentration at which PTC-treated water was avoided varied across rams. To our knowledge, this is the first study to test PTC as a tool to identify variation in bitter avoidance among sheep. Therefore, this study suggests that it may be possible to select sheep, based on demonstrated avoidance of PTC, for targeted grazing applications to manipulate vegetation towards range management goals.

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**Title:** Effect of Irrigation on Fiber Concentration and In-Vitro Fiber Digestibility of Corn Plant Tissues

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## Abstract

Water stress may be detrimental to corn plant growth due to the evident reduction in yield. While corn cell wall composition is directly correlated with digestibility in dairy cattle, the effects of water stress on corn plant cell wall composition is still unknown. The objective of this study was to determine the effect of irrigation on fiber concentration and in vitro fiber digestibility on stems, leaf-sheaths, and leaf-blades of corn for silage. Five commercial corn hybrids for corn silage (one of them showing the Brown Mid-Rib phenotype) were planted in a split-plot within a randomized complete block design with four replicates. Experimental treatments consisted of a control treatment (watered) with furrow irrigation at planting and three more times during crop growth, and a non-irrigated treatment (non-watered) with furrow irrigation only at planting. When the corn was between ¼ and ¾ milk-line, 10 corn plants from each plot were cut by hand at 15 cm above the ground, weighed, and chopped using a wood chipper. A 400-g sample of chopped material was dried to determine biomass dry matter (DM) concentration. A composite sample of the stems, sheaths and blades were collected from each of the plots. Samples were also collected from the upper and lower internodes. The samples were then dried at 55ºC and ground, first through a 5 mm Wiley Mill then through a 1 mm screen. Concentrations of in vitro DM, cell wall, neutral detergent fiber, and lignin were determined for each sample. Data were analyzed using Proc Mixed of SAS (version 9.4), and the model included the effects of block (random, df = 3), treatment (fixed, df = 1), block by treatment interaction or whole-plot error (random, df = 3), hybrid (fixed, df = 4), treatment by hybrid interaction (fixed, df = 4), and the residual or split-plot error (random, df = 25).

Watered plots contained less neutral detergent fiber concentrations than non-watered plots (64.6 vs. 67.6% NDF; $P < 0.01$). Watered plots had a greater in-vitro apparent DM digestibility than non-watered plots (56.7 vs. 54.8% IVDMD; $P < 0.05$). The in-vitro neutral detergent fiber digestibility tended to be greater for the watered plots than for the non-watered plots (51.7 vs. 50.1% IVNDFD, $P < 0.10$). This observation is contrary to the general industry belief that water-stress increases fiber digestibility in forages. The concentration of lignin within the cell wall was not affected ($P > 12$) by irrigation and averaged 19.3%. In summary, based on the data of this controlled study, limited water supply does not affect lignin concentration of the cell wall and does not increase the in-vitro digestibility of fiber in corn for silage.

**Title:** Effects of weaning and supplemental butyrate on calf performance and rumen fermentation in dairy calves

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This study examined the effect of the weaning transition and supplemental butyrate on feed intake and rumen fermentation in dairy calves. Holstein bull calves (n=36; age= 10.7 ± 4.1d) were assigned to one of four treatment groups: two pre-weaning groups, animals fed milk only (PRE-M) and those fed milk, calf starter, and hay (PRE-S); and two post-weaning groups, animals fed milk, calf starter, and hay without supplemental butyrate (POST-S) or with supplemental butyrate at a rate of 1% w/w during the weaning transition (POST-B). Milk was provided at 1200 g/d; starter, water, and hay were provided ad libitum. Weaning transition occurred in POST-S and POST-B by reducing milk replacer to 800 g/d in week 7 and 400 g/d in week 8, and complete weaning at week 9. Rumen pH was measured continuously for seven days prior to terminal sampling. At harvest, rumen fluid was sampled and analyzed for volatile fatty acids (VFA). Starter intake was measured daily; weights were measured weekly to calculate average daily gain (ADG). Between PRE-M and PRE-S, total VFA concentrations increased (11.8 ± 5.8 vs. 35.6 ± 5.6 mM, $P < 0.01$), but mean pH was unaffected (6.16 ± 0.83 vs. 7.44 ± 0.79, $P = 0.28$), suggesting the rumen can manage rumen pH despite increases in fermentation prior to weaning. Between PRE-S (age = 42 d) and POST-S (age = 63 d), calf starter intake increased (250 ± 219 vs. 2239 ± 219 g/d, $P < 0.01$), total VFA concentrations increased (35.6 ± 5.6 vs. 154.3 ± 15.0 mM, $P < 0.01$), but mean rumen pH was unaffected (7.44 ± 0.79 vs. 6.39 ± 0.19, $P = 0.48$), suggesting the rumen can also manage rumen pH during the weaning transition. Between POST-S and POST-B, starter intake increased (2239 ± 219 vs. 3094 ± 219 g/d; $P = 0.01$), total VFA concentrations were unaffected (154.3 ± 15 vs. 131.0 ± 15.8 mM, $P = 0.23$), and mean rumen pH decreased (6.39 ± 0.19 vs. 5.83 ± 0.18, $P = 0.05$), even though ADG increased (0.77 ± 0.04 vs. 0.92 ± 0.04 kg/d; $P = 0.03$), suggesting rumen pH is sensitive to dietary changes post-weaning. In all, these data suggest the rumen's ability to manage rumen pH changes fundamentally post-weaning. Additionally, the supplementation of calf starter with butyrate during the weaning transition helps to sustain greater calf starter intakes and ADG. Why calves with lower rumen pH can achieve greater calf starter intakes is unclear; these data suggest the impact of rumen pH on feed intake differs between calves and cows

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**Title:** Effect of agronomic selenium biofortified alfalfa hay on selenium status and glutathione peroxidase activity in transition dairy cows and their calves

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**Abstract**

Selenium (Se) is an important trace mineral for human and livestock. Selenium is an essential micronutrient for the antioxidant glutathione peroxidase (GPx) which is important to protect the cell from free radicals. Oxidative stress is particularly acute during early post-partum in dairy cows. Supplementation of selenium in pregnant cows can improve the Se status of their offspring, bursting theirs antioxidant capability and, thus, fostering a better health and growth performance. Se supplementation in ruminants is particularly important in region of low Se in soil, such as Oregon; however, inorganic Se supplementation is limited by FDA. Thus, feeding agronomic Se biofortified alfalfa hay to dairy heifers during pregnancy can improve their Se status, antioxidant activity, and the amount of Se transfer into the calves. To test the hypothesis, we used 18 primiparous cows (8 Holsteins and 10 Jerseys) fed ad libitum with a TMR based on grass silage (0.14 mg Se/kg DM). Cows were blocked by breed and randomly assigned to two groups. One group received from 40 days prior parturition to 2 weeks post-partum 1 kg agronomic Se biofortified alfalfa hay (3.2 mg/kg DM)/100 kg of BW mixed with the TMR (TRT). A group received alfalfa with low Se (0.4 mg/kg DM; CTR). Whole blood in cows and their calves and liver and milk samples of cows were used to determine Se and other trace minerals by ICP-MS. Plasma of cows and their calves, erythrocyte, and milk samples of cows were used to measure GPx activity by using a commercial assay kit. Dry matter intake and milk yielded were measured daily. Data were analyzed by GLIMMIX of SAS with the fixed effect of treatment, breed, time and their interactions and cows as random effect. PROC CORR was used to find the correlation between the variances.

After 4 weeks into the trial, Se concentration in blood increased 2-fold ($P$<0. 0001) in TRT vs. CTR (204.49±19.19 vs. 95.01±20.90 ng/ml) that results in greater ($P$<0.0001) Se in liver (1137.09±68.70 vs. 619.10±73.45 mg/g), Se in milk (48.3415±3.40 vs. 22.52±3.3562 ng/ml), and Se in blood of calves (215.50±10.92 vs. 161.22±10.92). GPx activity increased in plasma (92.84±3.44 vs. 77.88±3.36 nmol/min/mL) and erythrocyte of cows (549.23± 35.32 vs. 260.02± 34.15 nmol/min/mL) by Se biofortified hay, while only a numerical increase was detected in their calves and no effect was detected in milk GPx. Our results point out that feeding pregnant dairy heifers with a relative low amount of Se-fortified alfalfa hay is an effective way to increase Se in blood, liver, and milk, which is in turn improved antioxidant activity and the amount of Se that transferred into the calves.

**Keywords**: Agronomic Se; Selenium concentration blood; GPx; liver; Milk; dairy heifers; Calves