Grazing diverse combination of tanniferous and non-tanniferous legumes: Implications for foraging behavior, performance and hair cortisol in beef cattle

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Introduction

- Legume-based finishing systems take advantage of the unique ability of ruminants to utilize significant amounts of plant fiber for energy, and the high nutritional quality and fermentation rates of legumes relative to grasses (Villalba et al., 2019). Nevertheless, monocultures of legumes like alfalfa (*Medicago sativa* L.) impose limitations to production in part caused by the risk of bloat (Wang et al., 2012), and by the inefficient use of nitrogen due to imbalances in the ratio of nitrogen to energy (Getachew et al., 2006).
- One solution involves offering a diversity of forages with different types and concentrations of biochemicals (e.g., protein, non-fibrous carbohydrates, and plant secondary compounds like condensed tannins), thus promoting complementary or associative relationships that enhance animal welfare and nutrition (Villalba et al., 2011).
- **The aim of this study** was to evaluate the synergistic effect of increasingly diverse combinations of tanniferous (*Lotus corniculatus;* birdsfoot trefoil-**BFT**, *Onobrychis viciifolia*; sainfoin-**SF**) and non-tanniferous (alfalfa-**ALF**) legumes on foraging behavior, animal performance and hair cortisol in grazing cattle during the finishing process.

Methods

Twenty-one pairs of heifers grazed three spatial replications of seven treatments (3 pairs/treatment): Monocultures (BFT, SF, ALF) and all possible 2- and 3-way choices among strips of these legumes in a completely randomized block design in two 25-d periods during 2 consecutive years (Figure 1).

The foraging behavior of the pair was recorded using game cameras that captured images with a time-lapse of 5 min intervals (scans), recording: 1-grazing bouts, or 2-bouts of inactivity (not eating, resting, searching and drinking water) and type of legume selected (Figure 2).

Behavioral levels of activity (number of steps, motion index, % of time spent standing) were assessed with pedometers (Icetag3DTM). Hair samples were taken from one animal of each pair of heifers. Animals were shaved the first day of the adaptation phase and hair samples were collected on the last day of the experimental period to determine concentration of cortisol (Figure 2).

Results

Cattle grazing BFT gained more BW (1.14 Kg/d) than cattle grazing ALF or SF (0.93 Kg/d; P<0.10). Cattle in the 3-way choice (1.27 Kg/d), gained 27% more BW than the average of all monocultures (1.00 Kg/d; P=0.014), and 30% more than the average of all 2-way choice treatments (0.97 Kg/d; P=0.007).

Heifers offered choices, always selected a diverse diet (Figure 3). Animals offered 3-way choices were observed more times grazing sainfoin (46% of the total grazing scans recorded) than birdsfoot trefoil (27%) or alfalfa (26%). Likewise, when animals were offered 2-way choices containing sainfoin, they preferred this legume over alfalfa or birdsfoot trefoil in a 70:30 ratio (Figure 3).

Heifers preferred B. trefoil over alfalfa in a 60:40 ratio (P< 0.05; Figure 3). Heifers likely reduced their grazing time on alfalfa and B. trefoil in order to minimize the potentially toxic effects of rapid protein breakdown and ammonia accumulation in the rumen, frothy bloat (alfalfa), and at the same time incorporate condensed tannins from sainfoin.

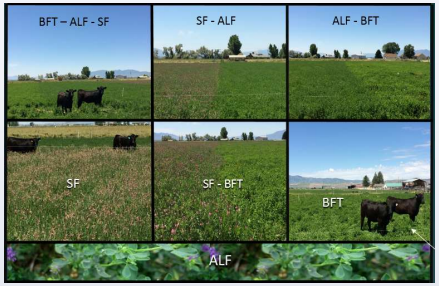

Figure 1. Experimental design. Heifers could choose among strips of alfalfa (ALF), birdsfoot trefoil (BFT) and sainfoin (SF), or they grazed the monocultures of these legumes.

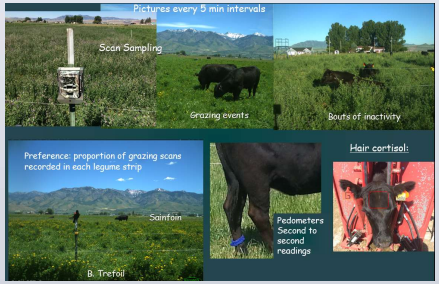

Figure 2. Foraging behavior was assessed using game cameras that captured images (scans) every 5 minutes. Number of steps, standing and lying bouts were determined with pedometers. Hair samples were taken from a 100 cm2 square area on the forehead to determine cortisol.

The proportion of total grazing scans was ~ 50 % for all treatments, except for BFT (a lower proportion of grazing scans) (P < 0.10; Figure 4). This may be related to sward structure in B. trefoil, with a more prostrate growth habit and higher bulk density than sainfoin or alfalfa, allowing for a greater bite mass (and thus reduced grazing time).

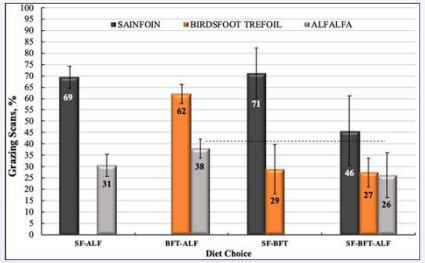

Figure 3. Percentage of grazing scans recorded for heifers grazing 3- or 2-way choices among strips of alfalfa (ALF), sainfoin (SF) or birdsfoot trefoil (BFT).

All treatments followed similar grazing patterns throughout the day (Figure 5), showing high synchronism among animals on monoculture or choice treatments. There were 2 peaks of grazing events, one hour after sunrise, and in the evening during 3 hours before dark, with the greatest percentages of grazing events (between 70 to 100%).

No differences among treatments were observed for the number of steps taken per day, the motion index or the % of time heifers spent standing (Table 1).

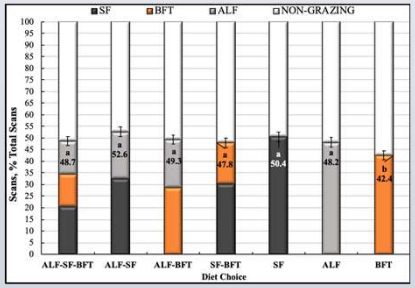

Figure 4. Percentage of total scans recorded for heifers grazing 3- or 2-way choices among strips of alfalfa (ALF), sainfoin (SF) or birdsfoot trefoil (BFT), or monocultures of these legumes.

Thus, heifers did not invest extra time in searching and forage switching activities when they were exposed to choices relative to monocultures. It is likely that the spatial aggregation of legumes (i.e., in strips or patches) contributed to explain this response as the manifestation of a preference occurred automatically after the selection of a specific feeding station (i.e., reduced searching and handling activities) in choice treatments.

Forage diversity did not reduce hair cortisol levels relative to animals grazing monocultures, with values ranging between 1.4 and 2.4 ng/g of hair.

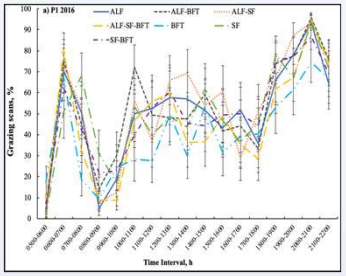

Figure 5. Grazing patterns (hourly grazing scans, %) by heifers grazing 3- or 2-way choices among strips of alfalfa (ALF), sainfoin (SF) or birdsfoot trefoil (BFT), or monocultures of these legumes.

Table 1. Behavioral levels of activity by heifers grazing 3- or 2-way choices among strips of alfalfa (ALF), sainfoin (SF) or birdsfoot trefoil (BFT), or monocultures of these legumes

Treatments	Standing Time, % of total daily time	Steps, number/d	Motion Index
ALF	44.2 (1.4)	1511 (148)	5033 494)
BFT	44.3 (1.7)	1447 (172)	4550 (576)
SF	46.2 (1.4)	1634 (145)	5180 (483)
ALF-SF	47.6 (1.4)	1731 (145)	5726 (483)
ALF-BFT	45.2 (1.4)	1566 (148)	5652 (494)
SF-BFT	44.1 (1.4)	1648 (145)	5132 483)
ALF-SF-BFT	45.7 (1.6)	1653 (162)	6222 (538)

Conclusions

Heifers offered choices preferred tanniferous legumes over alfalfa, selecting a diverse diet at the highest level of diversity that led to improvements in BW gains. No effect on hair cortisol was observed.

Forage diversity did not influence grazing events or behavioral levels of activity relative to monocultures, suggesting that foraging efficiency was maintained via the spatial distribution (patches) of the species on offer. The incorporation of a diverse array of chemicals into the diet may promote synergisms that benefit animal nutrition.

References

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