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# Influence of Season on Chemical Composition, Intake, Kinetic, Digestibility and Ruminal Fermentation of Diet Selected by Steers Grazing

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**Abstract:** We used four ruminally cannulated steers (350±3 kg) to evaluate the effect of season on chemical composition, intake, kinetic, digestibility and ruminal fermentation of diet selected during grazing. Data were analyzed as a randomized complete block design with months as the block and season of year as treatment. Time-sequence data than pH, ammonia Nitrogen ($NH_3N$) and Volatile Fatty Acids (VFA) were analyzed as repeated measures within a randomized block design. The Dry Matter Intake (DMI), Organic Matter Intake (OMI), Digestible Energy (DE), Metabolizable Energy (ME) and passage rate (Kp) of diet were affected by season ($p<0.05$). The Crude Protein (CP) and $NH_3N$ concentration were higher in the rain season ($p<0.01$). The content of NDF was different in seasons ($p<0.01$). Similar, acetate, propionate and butyrate concentrations were different ($p<0.01$). Changes in chemical composition, intake, kinetic, digestibility and ruminal fermentation observed in this study appeared to be related to season.

**Key words:** Intake, diet quality, ruminal fermentation, bovines, grazing, Mexico

## INTRODUCTION

Forages in semiarid environments tend to vary greatly in quality and quantity which subsequently affects diet composition and selectivity of grazing cattle (Obeidat *et al*., 2002). However, increasing maturity of forage usually corresponds to decreasing digestibility and intake, lower CP content and increased dietary fiber (Gelvin *et al*., 2004). These changes may be accompanied by decreases in ruminal ammonia ($NH_3N$) and total Volatile Fatty Acid (VFA) concentrations and increased acetate: propionate ratio (Funk *et al*., 1987). Similar changes appear to occur with advancing dry season in diet consumed for grazing cattle. Information concerning seasonal changes in diet quality when coupled with estimates of intake and digestibility, provides a foundation in dry season supplementation practices and sound nutritional programs. Limited information on intake, digestibility, kinetic and ruminal fermentation patterns in diet selected for cattle grazing is available. The study was designed to evaluate the changes in dietary nutrient composition, forage intake, digestibility and ruminal fermentation during seasons of year in steers grazing.

## MATERIALS AND METHODS

**Study area:** The study was carried in a medium-sized shrub-grassland with an average of forage biomass of 1,796 kg of DM $ha^{-1}$ (24° 22' N, 104° 32' W at an altitude of about 1938 m above sea level) which has a dry temperate ($BS_1k$) climate with average annual temperature and rainfall of 17.5°C and 450 mm, respectively. We estimated vegetation cover using minimum area sampling with nested points (Franco *et al*., 1985). Dominant grass species included *Melinis repens* Willd (rose natal grass), *Chloris virgata* (feather fingergrass), *Bouteloua gracilis* (blue grama), *Aristida adscensionis* (6 weeks threeawn) and *Andropogon barbinodis* (cane bluestem); bushes: *Acacia tortuosa* (poponax), *Prosopis juliflora* (mezquite), *Opuntia* sp. (prickly pears and chollas), *Mimosa biuncifera* (mimosa) also a wide variety of annual herbs.

**Animals and collection of diet samples:** We collected diet samples four steers cannulated of the rumen with a live weight of 350±3 kg. Surgery was performed on the steers according to procedures approved by the University of Durango Laboratory Care Advisory Committee. Eight sampling periods, each 12 days long were conducted from February-May (dry season) and July-October (rain season) during year 2008. At 7:00 h on day 1-3 of each sampling period, fecal samples were taken the rectum, to estimate total fecal output. Chromic oxide was used as an indigestible flow marker (10 g/steer/day) was dosed through the ruminal cannula. Fecal samples were analyzed for Cr content using the spectrophotometric method (Jordon *et al*., 2002). Fecal output was calculated by

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dividing amount of Cr dosed daily by Cr concentration in feces. Intake was calculated by dividing fecal output by *in vitro* indigestibility (Villanueva *et al*., 2003).

At 7:00 h on day 4-6 each sampling period, masticate samples were collected by the ruminal evacuation technique (Cline *et al*., 2009). Evacuated animals were allowed to graze freely for 30-60 min before ruminal masticate samples was collected. At 7:00 h on days 11-12 each sampling period ruminal samples were collected at 0, 4, 8 and 12 h. Immediately later collection, 100 mL of ruminal fluid was strained through four layers of cheesecloth and pH was measured. A 10 mL aliquot of ruminal fluid was acidified with 0.3 mL of 50% $H_2SO_4$ and a 10 mL aliquot of ruminal fluid was acidified with 2.5 mL of 25% metaphosporic acid and frozen (-20°C) for later ammonia-N and VFA analysis, respectively (Abdelhadi and Santini, 2006).

Digestible Energy (DE) and Metabolizable Energy (ME) was calculated using the formula: DE (Mcal $kg^{-1}$) = [0.039 x (% IVOMD)]-0.10 and ME (Mcal $kg^{-1}$) = DE (Mcal $kg^{-1}$) x 0.82 (Waterman *et al*., 2007). We determined Acid-Insoluble Ash (AIA) in samples the diet as well as in samples of ruminal contents according to Van Soest *et al.* (1991). We determined Kp dividing AIA content in the diet consumed by the steers by total AIA in the ruminal content (Ogden *et al*., 2005).

**Laboratory analyses:** Masticate samples were analyzed for DM, ash and CP (AOAC, 1999). Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Lignin (L) and Acid-insoluble Ash (AIA) (Van Soest *et al*., 1991). The *in vitro* Organic Matter Digestibility (IVOMD) was estimated (Huntington and Burns, 2007). Chromium concentration was determined by atomic absorption spectroscopy (Jordon *et al*., 2002).

**Statistical analysis:** Data were analyzed as a randomized block design with months as the block and season of year as treatment. With four repeated by treatment. Time-sequence data (ruminal pH, $NH_3N$ and VFA) were analyzed as repeated measures within a randomized block design and evaluated the interactions between season x time of day (Little *et al*., 1996). Analysis of data was conducted using GLM and MIXED procedures (SAS, 2003).

## RESULTS AND DISCUSSION

**Dietary composition:** Masticate CP concentration was higher 52.8% in rain season ($p<0.01$, Table 1). Many researchers have observed a steady decline in the CP content of grazed diets with advancing season and (or) stage of maturity (McCollum *et al*., 1985; Kirby and Parman, 1986; Brandyberry *et al*., 1991). Neutral detergent fiber, ADF and L concentrations in masticate samples were greater in dry season ($p<0.01$). The contents of NDF, ADF and L in dry season were 74.9, 56.3 and 7.1%, respectively. Johnson *et al*. (1998) have observed increases in masticate samples fiber content with advancing season. The study digestibility of Organic Matter (IVOMD) were lower in dry season ($p<0.05$). These data agree with data report from Olson *et al*. (1994). DE and ME content were greater in rain season ($p<0.05$). Observed differences are likely being driven by changes season that consequently affect plant growth and maturity (Olson *et al*., 2002).

Table 1: Chemical composition of diet consumed by steers grazing

| Chemical Composition | Season: Dry | Season: Rain | SE | Significance level |
|---|---|---|---|---|
| OM (%) | 91.0 | 89.3 | 1.10 | NS |
| CP (%) | 4.90 | 10.4 | 0.53 | ** |
| NDF (%) | 74.9 | 64.3 | 0.96 | ** |
| ADF (%) | 56.3 | 46.7 | 0.86 | ** |
| L (%) | 7.10 | 4.70 | 0.88 | ** |
| IVOMD (%) | 59.2 | 67.3 | 1.11 | * |
| DE (Mcal $kg^{-1}$ DM) | 2.20 | 2.50 | 0.29 | * |
| ME (Mcal $kg^{-1}$ DM) | 1.80 | 2.00 | 0.69 | * |

*p<0.05; **p<0.01

Table 2: Intake and passage rate of diet consumed by steers grazing

| Chemical Composition | Season: Dry | Season: Rain | SE | Significance level |
|---|---|---|---|---|
| DMI (kg $day^{-1}$) | 4.5 | 6.70 | 1.80 | * |
| OMI (kg $day^{-1}$) | 4.4 | 6.40 | 1.30 | * |
| DEI (Mcal $day^{-1}$) | 9.9 | 16.7 | 0.98 | * |
| MEI (Mcal $day^{-1}$) | 8.1 | 13.4 | 0.66 | * |
| Kp ($h^{-1}$%) | 1.6 | 2.50 | 0.97 | * |

*p<0.05; **p<0.01

**Intake and passage rate:** The DMI, OMI, Digestible Energy Intake (DEI), Metabolizable Energy Intake (MEI) and Kp were different between seasons ($p<0.05$, Table 2). Hirschfeld *et al*. (1996) reported that intake peaked concurrently with the onset of early stages of plant growth and declined steadily for the rest of the season. These differences could be influenced by different fiber contend in the diet (Sowell *et al*., 2003). The Kp in rain season was 2.5% $h^{-1}$ whereas Barton *et al*. (1992) reported different Kp 2.0 % $h^{-1}$. These data could have been due to differences in quality forage (Obeidat *et al*., 2002; Bhatti *et al*., 2008).

**Ruminal fermentation:** Season x time of day interactions were not present ($p>0.05$) for any ruminal fermentation parameters measured, therefore main effect means of season are shown in Table 3. Ruminal pH was 6.6 in dry season and 6.3 in rain season ($p<0.05$). During all seasons in the study were below those considered optimal for fiber digestion and cellulolytic bacterial growth.

Table 3: Ruminal pH, $NH_3N$ and VFA concentrations in steers grazing

| Chemical Composition | Season | | SE | Significance level |
|---|---|---|---|---|
| | Dry | Rain | | |
| pH | 6.60 | 6.30 | 0.95 | * |
| $NH_3N$ (mg $dL^{-1}$) | 4.70 | 11.5 | 1.27 | ** |
| Total VFA (mM) | 68.3 | 71.4 | 1.16 | * |
| **mol/100 mol** | | | | |
| Acetate | 66.4 | 63.8 | 0.98 | ** |
| Propionate | 13.8 | 16.6 | 0.73 | ** |
| Butyrate | 7.10 | 4.80 | 1.10 | ** |
| A:P | 4.80 | 3.80 | 1.32 | NS |
| Minor $VFA^+$ | 12.3 | 15.7 | 0.43 | ** |

*p<0.05; **p<0.01 +Isobutyrate, isovalerate and valerate

Concentrations of $NH_3N$ were different between season (p<0.01). Others researchers have observed decreases in ruminal $NH_3N$ concentrations when diet CP contend decreases with advancing plant maturity (Park *et al*., 1994). McCracken *et al*. (1993) report greater $NH_3N$ concentration in steers grazing tall fescue. Total VFA concentration in rain season were greater than in dry season (p<0.05).

Decreases in total ruminal VFA concentration with advancing forage maturity have been reported for a variety of forages types (McCollum *et al*., 1985; Adams *et al*., 1987; Krysl *et al*., 1987). Acetate concentration were greater in dry season (p<0.01). Propionate concentration were greater in rain season (p<0.01). Acetate is considered to be reflective of cell wall fermentation and increased acetate levels are normally associated with declining forage quality. Propionate is associated with soluble carbohydrate fermentation (Van Soest, 1982). Butyrate concentration were greater in dry season (p<0.01). Choat *et al*. (2003) reported similar acetate, propionate and butyrate concentrations. Minor VFA concentration in rain season were greater than in dry season (p<0.01). Minor VFA were highest during forage growth, declining to lowest levels while steers were grazing dormant forage (Van Soest, 1994).

## CONCLUSION

Identification of nutritional deficiencies in grazing cattle diets is essential for formulation of supplementation strategies to optimize animal performance. The results of this study indicate that chemical composition, intake, digestibility and ruminal fermentation of diet selected for steers grazing were affected by season of year. Nutritional deficiencies in dry season were registered. Therefore, protein and energy supplementation is necessary in dry season, depending on desired performance level and nutrient requirements.

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