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Organic Matter Degradability of Diets by Range Goats

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Abstract: The rate and extent of organic matter digestion of range goat diets was seasonally estimated from August 2006 to May 2008 in a shrubland from Baja California, Sur, Mexico. Five esophageal cannulated adult female range goats (40 kg of BW) were used to collect extrusa samples. Nylon bags (5×10 cm and 50 μm of pore size) containing 5 g of each extrusa sample were incubated at 0, 3, 6, 12, 24, 48 and 72 h in the ventral part of the rumen of four ruminal fistulated goats that were browsing in the range with the herd. The soluble fraction of OM, the rumen degradable fraction, the rate constant and Effective Degradability of Organic Matter (EDOM) were significantly different among seasons; however, year effect and seasons x year interaction were not significant ($p>0.05$). It appeared that rainfall influenced positively EDOM because during summer and autumn (wet seasons), in both years, goats digested more dietary OM that in other seasons (dry months). Moreover, as dietary cell wall fractions increased (winter and spring), EDOM decreased. Results indicate that degradability of OM depicted a lower nutrient availability by range goats during the dry seasons.

Key words: Organic matter degradability, range goat diets, Northwest Mexico

INTRODUCTION

The *in situ* technique is an alternative method that closely simulates the rumen environment for a given feeding regimen. This method may provide information concerning the effective degradability of the chemical constituents of the feedstuff in the rumen (i.e., the estimated proportion of feed nutrients that can be degraded in the rumen). And may also, be a useful method to estimate energy digestibility of feedstuffs in the rumen (Gosselink *et al*., 2004). Moreover, the nutritive value of forage is closely related to the rate of disappearance of material from the rumen (Dove and McCormack, 2008).

Baja California Sur, Mexico is considered as an extremely arid zone, 92% of its flora is composed by shrubs and 23% of these, are endemic species. Livestock production systems, in these areas, are based mainly on range goats and beef cattle and most farmers are traditional-smallholder; however, there is an extreme lack of information on the value of organic matter digestibility of diets by range goats. Consequently, the aim of this study, was to determine and compare seasonally the OM degradability characteristics of range goat diets during 2 consecutive years in scrubland from northwestern Mexico.

MATERIALS AND METHODS

The study was conducted in the ranch Palmar de Abajo (800 ha) located in La Paz, Baja California Sur, Mexico situated at 23°38' 40 north latitude and 110° 18 07 west longitude. It is 200 m over sea level. Vegetation is composed mainly by shrubs from 1-3 m and threes from 4-10 m of height. The climate of the region is arid with annual mean temperature of 21.2°C. The annual precipitation is about 182 mm, generally (80%) recorded from July through September. Rainfall and temperatures pattern from 1977-2002 are shown in Fig. 1. The main soils are of the type alkaline, regosol, eutric and calcareous, which are very permeable. The state of Baja California Sur is located in a subtropical zone, which is characterized by a very dry and warm weather BWhw, with rains during summer and early autumn; however, rainfall may occur winter (Ramirez-Orduna *et al*., 2003).

From August 2006 to May 2008, 5 esophageal cannulated adult female range goats (40 kg of BW) were used to collect extrusa samples. Collections were carried out in summer (9-13 August) and autumn (29 November to 3 December) of 2006, winter (20-24 February), spring (29 April to 5 May), summer (10-15 September), autumn (4-8 December) of 2007 and in winter (20-25 February) and

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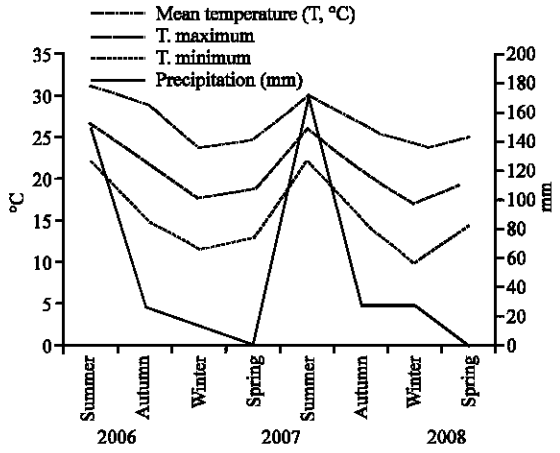

Fig. 1: Means of seasonal precipitation (mm), mean, maximum and minimum air temperature (°C) from 1977-2002 at Todos Santos meteorological station, Baja California Sur, Mexico

spring (9-13 May) of 2008. In each collection period, animals were sampled during six consecutive days; first 3 days at 08:00 and the rest at 17:00 h. Goats were fitted with canvas collection bags with screen wire bottoms and allowed to graze freely during 45 min. After collection, animals were allowed to browse freely with the herd and at the end of the day were confined in corral overnight for fasting. Goats remained with the herd the rest of the year and were treated the same way. Fistula extrusa samples were mixed thoroughly by hand, placed in plastic bags and frozen (-4°C). Subsequently, samples were thawed and pooled across the 6 days collection period for each animal. Later, samples were partially dried in a forced-air oven at 55°C for 72 h, ground to pass a 1 mm screen in a Wiley mill to reduce all plant fragments to a uniform size, Two subsamples were taken and stored in plastic containers for *in situ* digestibility analyses.

The rate and extent of digestion of organic matter was estimated by incubating nylon bags (5×10 cm of size with a pore size of 50 μm; ANKOM Technology, Macedon NY, USA), containing 5 g of each extrusa sample. Bags were incubated at 0, 3, 6, 12, 24, 48 and 72 h in the ventral part of the rumen of 4 ruminal fistulated goats that were browsing in the range with the herd. During each incubation period, the bags were placed into the rumen at once. After withdrawal, bags were placed in polyethylene bags and washed several times until the rinsing water was clear. The bags were dried in a convection oven during 24 h at 55°C and stored in plastic containers until ash analyses were performed. The OM bag losses were estimated by weight change of nylon bags before and after washing and disappearance of OM for each incubation time was calculated by:

$$\text{OM disappearance (\%)} = \frac{\text{Initial OM-final OM}}{\text{Initial OM}} \times 100$$

Digestion characteristics of OM were obtained by fitting data to the equation (Orskov and Shand, 1997):

$$P = a+b\,(1-e^{-ct})$$

where:

a = Represents the immediately soluble fraction
b = The insoluble but slowly rumen degradable fraction
a+b = The potential degradation
c = The rate constant of degradation of b
t = The time of incubation

Effective Degradability of OM (EDOM) was calculated by the following equation:

$$EDOM = (a+b)c/(c+k)\,(e^{-(ct)LT})$$

assuming a rumen out flow rate of 5% h^{-1}. Data were statistically analyzed using a factorial design of A × B where A were years (2) and B seasons (4). Mean differences were separated using Tukey's test. Simple linear correlation coefficients were performed between chemical composition of diet selected by goats reported by Armenta-Quintana (2008), rainfall, air temperature and *in situ* digestibility parameters and EDOM (Cody and Smith, 1997).

RESULTS AND DISCUSSION

The soluble fraction of OM, the rumen degradable fraction, the rate constant and EDOM were significantly different among seasons; however, year effect and seasons x year interaction were not significant ($p>0.05$; Table 1).

It appears that rainfall influenced positively EDOM (Table 2) because during summer and autumn (wet seasons), in both years, goats digested more OM that in other seasons (Table 1).

Similarly, Ramirez-Orduna *et al.* (2008) reported that OM digestibility of goat diets was also, higher during wet seasons and diets were composed mainly by browse plants. In addition, higher degradability of nutrients during wet seasons was reported by Juarez *et al.* (2004) and Cerrillo *et al.* (2006) in diets selected by range goats in shrublands of north Mexico.

However, Ramirez-Orduna *et al.* (2003) reported a lower EDOM during spring and summer in individual

Table 1: *In situ* digestibility parameters a-c and effective degradability of organic matter by range goat diets in a shrubland of Baja California, Sur, Mexico

Years	Seasons	a (%)	b (%)	c (h^{-1})	EDOM[1]
1	Summer	23.4±2.1^{bc}	48.4±2.1^{d}	0.13±0.01^{b}	58.2±3.2^{d}
	Autumn	17.2±0.8^{a}	40.1±1.1^{bc}	0.12±0.01^{ab}	45.2±1.0^{bc}
	Winter	18.8±0.7^{a}	38.8±2.2^{bc}	0.08±0.01^{ab}	45.6±1.8^{bc}
	Spring	20.7±0.4^{ab}	31.0±1.4^{a}	0.10±0.01^{ab}	41.0±1.2^{ab}
	Mean	20.1±0.6	39.0±1.3	0.12±0.01	47.1±1.4
2	Summer	25.4±0.7^{c}	47.9±0.9^{d}	0.11±0.02^{ab}	51.5±0.8^{cd}
	Autumn	20.2±1.1^{ab}	45.8±1.0^{cd}	0.11±0.01^{ab}	48.6±1.4^{c}
	Winter	20.0±0.7^{ab}	33.8±2.1^{ab}	0.07±0.01^{a}	37.7±1.4^{a}
	Spring	18.7±0.7^{a}	35.3±1.3^{ab}	0.10±0.02^{ab}	46.2±1.6^{bc}
	Mean	21.2±0.5	40.4±1.1	0.09±0.02	46.0±0.9
	Total mean	20.8±0.4	39.9±0.8	0.10±0.02	46.4±0.8
	Effects				
	Year (A)	ns	ns	ns	ns
	Season (B)	***	***	***	***
	A × B	ns	ns	ns	ns

^{a,b,c,d}Means and standard deviations in a column with different letter superscripts are different ($p<0.05$), [1]EDOM = Effective Degradability of Organic Matter assuming a rumen out flow rate of 5% h^{-1}, ***($p<0.001$); ns = not significant

Tabla 2: Simple linear correlation coefficients between chemical composition of got diets and *in situ* digestibility parameters and Effective Degradability of Organic Matter (EDOM) and precipitation and temperature

Concept	a	b	c	EDOM
Neutral detergent fiber	-0.37**	-0.66***	-0.30*	-0.79***
Acid detergent fiber	-0.37**	-0.68***	-0.35**	-0.87***
Hemicellulose	0.06	0.06	0.11	0.19
Lignin	-0.28*	-0.43**	-0.25	-0.57***
Cellulose	-0.22	-0.50***	-0.22	-0.62***
Crude protein	0.19	0.21	-0.07	0.19
Metabolizable energy	0.26	0.30*	0.32*	0.53***
Precipitation	0.51***	0.11	0.27	0.55***
Temperature	0.21	0.22	0.11	0.23

*($p<0.05$); **($p<0.01$); ***($p<.001$)

forage species collected by hand clipping on a similar rangeland from Baja California, Sur enhancing the opportunistic selective grazing behavior of range goats (Ramirez-Orduna *et al*., 2008).

In this study, as dietary cell wall fractions (NDF, ADF, Lignin and cellulose) increased, EDOM decreased (Table 2).

Negative correlations between cell wall constituents and ruminal digestion parameters may indicate the detrimental effect such compounds exert on OM digestion of goats.

Similarly, Ramirez-Orduna *et al.* (2003) reported that EDOM and non structural carbohydrates content decreased when cell wall components were increasing at the time of crop maturity; moreover, lignin content appear to be the most important component limiting EDOM. Cerrillo *et al.* (2006) also found negative correlation between fiber fractions and digestibility of diets of goats browsing on a shrubland of north Mexico.

Moreover, Papachristou and Nastis (1993) reported that the poorly digestible compounds of diets selected by goats such as NDF and lignin negatively affect digestibility.

Results obtained in this study also, indicate that degradability of OM depicted a lower nutrient availability during the dry seasons; thus, OM at this point may be used to identify differences among forages consumed by grazing goats throughout the year. Conversely, high EDOM during the summer months, in both years, may indicate that goats had a good nutrient intake to maintain productivity (Ramirez *et al*., 2000).

CONCLUSION

The data suggests that OM degradability may be used to identify differences in seasonal diets consumed by browsing goats throughout the year. Due to the fact that goats were managed under a traditional extensive system where land is of communal use and shared with other range animals and that grazing areas with highest forage availability were always selected by the shepherd, results from the present study cannot be directly extrapolated to different practical conditions.

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