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ORGANIC MATTER AND CRUDE PROTEIN RUMINAL DEGRADATION SYNCHRONY IN DIETS SELECTED BY RANGE GOATS

[SINCRONIA DE LA DEGRADACION RUMINAL DE LA MATERIA ORGANICA Y PROTEINA CRUDA EN DIETAS SELECCIONADAS POR CAPRINOS EN PASTOREO]

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SUMMARY

The study was carried out with the aim to asses the synchrony of organic matter and crude protein degradation in the rumen of diets selected by range goats through two years. Five esophageal cannulated adult male goats were used to collect extrusa samples during summer (August 9–13) and autumn (November 29 –December 3) of 2006, winter (February 20 – 24), spring (April 29 –May 5), summer (September 10–15) and autumn (December 4–8) of 2007 and winter (February 20 – 25) and spring (May 9 –13) of 2008. Extrusa samples were subjected to chemical analysis to determine organic matter (OM), crude protein (CP) *in situ* and *in vitro* true digestibility of dry matter. OM and CP intake were estimated by total fecal collection. Effective extent of degradation of the OM and CP was calculated hourly and total 24 hours. From the hourly quantity of OM and CP degraded, a synchrony index of CP to OM was calculated, and from the total 24 hours degradation, degraded organic matter intake and crude protein intake were also estimated. Sampling date was the main effect that determined the variation of diet OM and CP degradation parameters. Degraded crude protein intake as a proportion of degraded OM was affected by sampling date and was correlated to rainfall. During winter of the first year degraded crude protein intake was below the requirements for maintenance or to promote growth for range goats weighing 40 kg. Even though, synchrony index between OM and CP degradation was affected by sampling date goats maintained a high synchrony index throughout the years.

Keywords*:* Range goats; Sonoran desert; Synchrony index; Diet digestibility; Forage intake

RESUMEN

Este estudio fue conducido con el objetivo de evaluar la sincronía de la degradación de materia orgánica (MO) y proteína cruda (PC) en el rumen de dietas seleccionadas por caprinos en libre pastoreo durante dos años. Cinco caprinos machos adultos provistos con cánulas en el esófago fueron usados para colectar muestras esofágicas de la dieta durante el verano (Agosto 9–13) y otoño (Noviembre 29 –Diciembre 3) de 2006, invierno (Febrero 20 – 24), primavera (Abril 29 –Mayo 5), verano (Septiembre 10–15) y otoño (Diciembre 4–8) de 2007 y en invierno (Febrero 20 – 25) y primavera (Mayo 9 –13) del 2008. Las muestras esofágicas fueron sujetas a análisis químicos para determinar MO, PC digestibilidad *in situ* e *in vitro* verdadera de la materia seca. El consumo de MO y PC fueron estimados mediante la técnica de colección fecal total. La degradabildad efectiva de material orgánica y proteína cruda fue calculada durante cada hora y en un total de 24 horas. El índice de sincronía fue calculado a partir de la cantidad de materia orgánica y proteína cruda degradada cada hora, el consumo de materia orgánica y proteína cruda degradada fue también estimado a partir de la degradación durante 24 horas. La fecha de muestreo fue el efecto principal que determinó la variación en los parámetros de degradación de la materia orgánica y proteína cruda. El consumo de proteína cruda degradada como proporción de la materia orgánica degradada fue afectado por la fecha de muestreo y se correlacionó con la precipitación pluvial. Durante el invierno del primer año el consumo de proteína fue inferior al requerimiento para el mantenimiento o para la ganancia de peso en caprinos en pastoreo con peso

de 40 kg. Sin embargo aun cuando el índice de sincronía entre la degradación de materia orgánica y proteína cruda fue afectado por la fecha de muestreo, los caprinos mantuvieron un elevado índice de sincronía de la energía y la proteína disponible en el rumen a lo largo de ambos años.

Palabras clave*:* Caprinos en pastoreo; Desierto de Sonora; Índice de sincronía; Digestibilidad de la dieta; Consumo de forraje

INTRODUCTION

Rangelands of Baja California Sur, Mexico are part of the Sonoran Desert and are considered as an extremely arid zone (FAO, 1987). About 92% of its flora is composed of shrubs and trees including *Bursera*, *Jatropha*, *Olneya*, *Cercidium*, *Fouquieria* and *Prosopis* genera and small-leaved shrubs. This vegetation plays an important role in this area with long dry period and harsh environmental conditions, because they provide green forage for range goats throughout the year (legume species) or at specific periods of the year (forbs, cacti and non-legumes trees and shrubs). It has been reported (Ramirez-Orduña et al., 2008) that at the end of spring, goats selected higher amounts of legumes browse and cacti species, but during late summer, autumn and winter goats mainly preferred non-legumes browse followed by forbs species and that legume and/or non-legume trees and shrubs explained at least 50% of the botanical composition of goats diet year round.

Range goats may select particular foods because they anticipate the benefits, rather than because they prefer the flavors; In addition, they discriminate among foods with their senses and sense the consequences of food selection through feedback mechanisms, both of which are integrated within the central nervous system (Forbes, 2007). Physiological state of the organism may influence food selection; however, this state-dependent food selection has not been studied in ruminants (Forbes and Provenza, 2000). Although the nutritional quality of forage selected by range goats varies from poor (Juarez *et al*., 2004) to medium quality (Landau et al., 2000) its nutritional quality did not fall very much during the dry season in harsh environments (Ramirez-Orduña et al., 2008). The main advantage of desert goats over goats from temperate areas while digesting medium quality roughage may relate to their ability to maintain higher microbial density on the particulate matter, hence a higher total ruminal fermentation rate and higher volatile fatty acids production, and this was related to their superior urea recycling capacity (Krehbiel et al., 2008); However, within 8-20 % dietary protein concentration, urea excretion iin the urine is a function of protein intake with no special retention mechanism in the kidney (Silanikove, 2000), therefore it is hypothesized that goats can be able to select diets with a high synchrony index between organic matter (OM) and crude protein (CP) degradation with the aim of maintaining relatively constant forage nutrient digestion in the rumen. In this regard, Richardson et al. (2003) in sheep and Kim et al. (1999) in dairy cows reported improvements in microbial efficiency and yield when synchronizing the hourly release of energy and N in the rumen. Thus, the aim of the study was to determine and compare the synchrony of OM and CP degradation of diets selected by range goats through two years.

MATERIALS AND METHODS

Research protocols, animal care and management procedures were in accordance with Institutional Animal Care and Use Committee. The study was conducted in the ranch "Palmar de Abajo" (800 hectares) in a 200-ha rangeland with a stocking rate of 0.13 to 0.36 heads/hectare, located in La Paz, Baja California Sur, Mexico at 23° 38´ 40´´ North latitude and 110° 18´ 07´´ West longitude with an elevation of 200 m above sea level. Vegetation is composed mainly of shrubs from 1 to 3 m, and trees from 4 to 10 m of height. The weather of the region is arid with annual mean temperature of 21.2 ºC. Historically, annual precipitation is about 182 mm and about 80% is registered from July through September. Weather data registered during this study are shown in Table 1. The main soils types are alkaline, regosol, eutric and calcareous which are very permeable (INEGI, 2001). The state of Baja California Sur is located in a subtropical zone which is characterized by a very dry and warm weather (BWhw, Köppen system); however, rainfall may occur in winter (INEGI, 2001).

Five esophageal cannulated adult Anglo Nubian male goats (40±1.7 kg of BW) were used to collect extrusa samples. Collections were carried out in summer (August 9–13) and in autumn (November 29 – December 3) of 2006, winter (February 20 – 24), spring (April 29 –May 5), summer (September 10–15) and autumn (December 4–8) of 2007 and winter (February 20 – 25) and spring (May 9 –13) of 2008. In each collection period, animals were sampled during 5 consecutive days; first 3 d 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 a pen overnight for fasting. Goats remained with the herd the rest of the year and were treated the same way. Esophageal extrusa

samples were mixed thoroughly by hand, placed in plastic bags and frozen (−4 °C). Subsequently, samples were thawed and pooled across the 5-d 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 1mm screen in a Wiley mill and stored in plastic sealed bags for *in situ* digestion and chemical analyses.

In each collection period, by triplicate, extrusa samples from each goat were subjected to chemical analysis to determine dry matter (DM), ash, OM and CP by micro-Kjeldahl assay (AOAC, 2000). The *in vitro* true digestibility of dry matter (IVDMD) was determined in a Daisy II *in vitro* incubator ((D200, Ankom Technology, Macedon, NY) using ruminal fluid from four ruminally cannulated range goats browsing in the same area, 1000 ml of ruminal fluid from each animal were filtered through four layers of cheesecloth into a preheated thermos (by filling with 39°C water and emptied just prior to fluid collection) at the morning before the grassing time, thermos containing ruminal fluid were purged continually with CO_2 and transported into a water bath at 39 °C up to the laboratory were the in vitro digestibility try was carried out immediately. In addition, five castrated adult male Creole-Nubio goats (37±1.4 kg of body weight), fitted with fecal collection bags were utilized to determine daily fecal output (FO). The dry matter intake (DMI; g/d) was calculated as: *DMI = FO/ (100 – IVDMD)*, where *FO* = fecal dry matter output and *IVDMD* (%) = *in vitro* dry matter digestibility (Burns et al., 1994).

Four range Creole-Nubio castrated male goats fitted with ruminal cannulas (37.1±1.35 kg body weight) were used to estimate the rate and extent of OM and CP loss of each extrusa sample at each sampling date. The animals were fed with *Medicago sativa* hay (14% CP) twice a day (8:00 and 18:00 h) and had free access to water. About 3 g of DM of each extrusa sample were placed into nylon bags (5 x 10 cm and 50 µm pore size). Duplicated bags were incubated in the ventral part of the rumen of each goat for 1, 2, 3, 4, 8, 12, 24, 48, 72 and 100 hours. After incubation, bags were withdrawn together and washed through 5 cold rinse cycles of 1 minute in a domestic washing machine. Zero-time (washing losses) was estimated by soaking three bags per sample in warm tap water at 39 °C for 20 min. After washing, bags and content were dried in an oven at 55 °C for 48 h and reweighed, residuals were analyzed for OM and CP (AOAC, 2000). The *in situ* digestibility (ISD) of OM and CP of every incubation time was calculated using the following equation: *ISD* (%) = *[(Initial weight – final weight)/Initial weight]/ 100*.

To estimate the non-linear parameters of ruminal digestion of OM and CP, *in situ* data set from nylon bags were fitted to the equation (Ørskov and McDonald; 1979): $P= a+b(1-exp^{-kd \cdot t})$. Where *P* is the cumulative amount degraded of OM or CP at time *t*, *a* is the readily soluble fraction of the sample that is lost during washing, *b* is the insoluble fraction that is potentially degraded in the rumen, *kd* is the constant rate of degradation of the fraction *b*, and *t* is in hours, the incubation time.

Table 1. Means of seasonal precipitation and temperatures registered during 2006 to 2008 at Todos Los Santos meteorological station, Baja California Sur, México

Year	Season	Precipitation (mm)	Temperature (°C)		
			Mean	Max	Min
1	Summer, 2006	147.5	26.5	30.9	22.2
	Autumn, 2006	27.0	22.0	28.9	15.2
	Winter, 2007	14.0	17.6	23.8	11.5
	Spring, 2007	0	18.7	24.6	12.9
	Annual mean	**174.5**	**21.2**	**27.0**	**15.4**
2	Summer, 2007	172.5	26.0	29.8	22.3
	Autumn, 2007	28.1	20.4	26.1	14.8
	Winter, 2008	26.0	16.8	23.8	9.9
	Spring, 2008	0	19.5	24.7	14.3
	Annual mean	**226.6**	**20.7**	**26.1**	**15.3**

The effective extent of degradation (ED) of the OM (EDOM) and CP (EDCP) was calculated hourly and total (24 hours) using the equation: $ED = a + \{[(b \bullet kd)/(kd+kp)][1-exp^{(kd+kp)\bullet t}]\}$. Where kp represents the outflow rate from the rumen. The EDOM and EDCP were estimated using an outflow rate of 5%/h. The quantity of OM and CP degraded each hour for each sample from each feeding time was calculated as the difference between that degraded at successive hours. From the hourly quantity of OM and CP degraded, a synchrony index (SI) of OM to CP was calculated as described by Sinclair *et al*. (2000): $SI = \{25-\Sigma 1-24\ (\sqrt{\ }[(25-\text{hourly N/OM})^2])/24\}/25$. Where 25 = 25 g of N/kg de OM truly digested in the rumen, which is assumed to be the optimal ratio (Czerkawski, 1986). A synchrony index of 1.0 represents perfect synchrony between OM and CP release throughout of day and values less than 1.0 indicate the degree of asynchrony. The daily quantity of OM and CP degraded was calculated as the sum of the hourly quantity degraded. Intake of degraded OM (DOMI) and CP (DCPI) were calculated from the estimated DMI and the daily quantity of degraded OM and CP, respectively.

Data of OM and CP intake, degradation parameters, and synchrony index of OM and CP degradation were subjected to analysis of variance for a factorial experimental design with sampling date and animals as the main effects and their interactions. Means were separated using Tukey´s test. Simple linear correlation coefficients were performed between degradation data and climatic variables (rainfall and temperature). All tests were performed with alpha ≤ 0.05 (SAS, 2000).

RESULTS AND DISCUSSION

According to the F values and significance of the analysis of variance (Table 2), sampling date was the main effect that determined the variation of diet OM and CP degradation parameters. Conversely, animal effect was not significant in determining the rate constant of OM and most of CP degradation parameters. The diet degradation parameters of OM and CP that are shown in Table 3 were significantly different between sampling dates, except for the rate constant (kd) of CP degradation.

Table 2. F values and significance of main effects on extrusa organic matter, crude protein, degradation parameters and intake of goat diets on a sarcocaulescent scrubland, Baja California Sur, México

	Sampling date	Animal	Sampling date x Animal
Organic matter, g/kg	267.8***	65.63***	38.0***
Organic matter intake, g/d	26197.9***	9776.48***	4123.1***
a, %	7.3***	2.72*	3.2***
b, %	51.7***	10.83***	6.4***
kd, h	3.9**	1.76ns	1.1ns
a+b, %	40.8***	16.50***	9.2***
Effective degradability, %	81.7***	25.49***	9.7***
DOMI, g/d	372.8***	103.39***	30.9***
UOMI, g/d	137.5***	68.47***	52.9***
Crude protein, g/kg	21.5***	0.88ns	1.5ns
Crude protein intake, g/d	59.9***	14.25***	3.5***
a, %	16.4***	2.23ns	2.9***
b, %	4.8***	1.92ns	1.3ns
kd, h	1.7ns	1.61ns	1.3ns
a+b, %	4.8***	1.69ns	2.1**
Effective degradability, %	37.2***	8.11***	3.7***
DCPI, g/d	91.9***	13.68***	1.7*
UCPI, g/d	15.2***	7.01***	5.7***
DCPI, g/kg of degraded OM	21.9***	1.5ns	1.0ns
Synchrony index	5.9***	1.1ns	1.3ns

DOMI = degraded organic matter intake; UOMI = undegraded organic matter intake; DCPI = degraded crude protein intake; UCPI = undegraded crude protein intake; ***(P<.001); **(P<.01); *(P<.05); ns = no significant.

The OMI of range goats was highest in winter of the second year and lowest in autumn of the same year. The EDOM was highest in summer of the first year and was lowest in autumn of the second year. The DOMI followed the same tendency as EDOM. However, undegraded OMI was higher in winter of the second year and was lowest in autumn of the first year (Table 3). It appeared that air temperatures negatively influenced the OM, OMI and UOMI content in goat diets (Table 4). The OMI and UOMI values decreased during summer to autumn (warmest seasons) but increased during winter and spring (coldest seasons, Table 3). Above the thermoneutral zone, body temperature raises and food intake decreases in order to reduce the heat production associated with feeding, digestion absorption and metabolism to prevent an excessive increase in body temperature (NRC, 1981; Forbes and Provenza, 2000); in addition, to the direct effect on animals, high environmental temperatures affect the growth of forages increasing the proportion of cell walls constituents, especially in C4 plants, because of the faster maturation (NRC, 1981; Buxton and Fales, 1994), and the increase in stem:leaf ratio reducing the nutritive value and palatability of the herbage (Forbes, 2007), reported data from the sarcocaulescent scrubland by Ramirez-Orduña et al. (2003a, b) shown that effective degradation of OM from non-legumes species and CP from legumes and non-legumes species were subjected to a seasonal effect. Rainfall influenced positively the soluble fraction (**a**) of OM and EDOM (Table 4) of goat diets, according to this result Ramirez-Orduña et al. (2008) also found that OM digestibility of goat diets, composed mainly for browse species, was higher during wet seasons. In addition, Juarez-Reyes et al. (2004) and Cerrillo-Soto et al. (2006) reported higher nutrient degradability, during the wet seasons, in diets selected by range goats in rangelands of North Mexico.

In this study, CPI was higher in winter of the second year and was lower in autumn of the first year. The EDCP was also higher in winter of the second year and was lower in autumn of the same year. The same tendency as EDCP occurred for DCPI. The undegraded CPI was higher in summer of the first year and lower in autumn of the same year (Table 3). Unlike OM intake, it seems that goats selected diets with high CP when it was available, because extrusa CP, CP intake, degraded and undegraded crude protein intakes were correlated positively to rainfall (Table 4), these variables were high during summer of the first year and winter of the second year. During winter of the first year degraded crude protein intake was below the requirements for maintenance (43 g/day) or growth of male castrated goats of indigenous breeds weighing 40 kg (NRC, 2007), conversely degraded crude protein intake was highest during winter of the second year (Table 3).

In this study, the DCPI in g/kg of the DOM was higher in winter of the second year and was lower in spring of the first year (Table 3). Rainfall correlated highly with this variable (Table 4); therefore, there was a higher intake of degraded CP in relation to degraded OM during summer of both years and winter of the second year. In all sampling dates, except winter of the second year, DCPI was under the value 210 g of CP/ kg of DOM, this value was derived from cattle and sheep data and is considered that below this value there is complete net transfer of ingested protein to the intestines as microbial, undegraded and endogenous protein, losses of protein or incomplete net transfer and absorption of ammonia will occur when protein content exceeds this value (Poppi and McLennan, 1995). Many tropical legumes exceed this value, however, presumably for plants containing condensed tannin the CP percentage at which incomplete net transfer occurs could be much higher because of the lower degradability of plant protein (Poppi and McLennan, 1995).

Even though, the synchrony index between OM and CP degradation in goat diets significantly varied among sampling dates, in general, goats maintained a high synchrony index in both years (Table 3). At the end of spring, goats selected higher amounts of browse legumes and cacti species, but during late summer, autumn and winter goats mainly preferred browse non-legumes followed by forbs, this selection resulted in a constant diet in truly digestible CP (annual mean = 11±0.4% DM) and metabolizable energy (2.4±0.1 Mcal kg−1) throughout the year (Ramirez-Orduña et al., 2008), presumably to maintain good ruminal fermentation, microbial protein synthesis and feed utilization (Chumoawadee et al., 2006). Cole and Todd (2008) argued that the net portal uptake of urea was greater in lambs fed oscillating CP than in lambs fed constant CP concentrations. In addition, the total urea recycling might have buffered the effects of asynchronous energy (OM) and N (CP) supply to the rumen of goats (Reynolds and Kristensen, 2008) during harsh dietary seasons. There were no relationships between the synchrony index and climatic conditions of the study area (Table 4).

Table 3. Means and standard errors of organic matter and crude protein in extrusa samples, organic matter and crude protein degradation parameters of extrusa samples, degraded organic matter and crude protein intakes and undegraded organic matter and crude protein intakes by range goats trough two years

Item	2006-2007				2007-2008			
	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
OM, g/kg DM	788±2.6^{d}	768±2.9^{f}	816±2.7^{a}	781±2.7^{e}	799±42.1^{c}	781±7.3^{e}	809±1^{b}	821±3.8^{a}
OMI, g/d	985±39.6^{b}	712±18^{g}	936±20.8^{d}	898±14.3^{e}	765±61.1^{f}	685±67.5^{h}	1310±59^{a}	958±44.6^{c}
a, %	24±1.5^{ab}	21±1.7^{bc}	20±0.9^{c}	22±0.6^{abc}	25±0.7^{a}	20±1.2^{c}	20±0.7^{c}	19±0.8^{c}
b, %	50±2^{a}	38±1.3^{cd}	39±1.7^{c}	32±1.3^{e}	35±1.3^{de}	34±2.2^{de}	48±0.9^{ab}	46±1.1^{b}
kd, %/h	13±1^{a}	11±1^{ab}	11±1^{ab}	10±1^{ab}	10±1^{ab}	7±1^{b}	11±2^{ab}	8±1^{b}
Effective degradability	60±2.3^{a}	47±1^{c}	47±1.5^{c}	43±1.2^{d}	47±1.5^{c}	38±1.4^{e}	52±0.8^{b}	46±1.7^{c}
DOMI, g/d	588±28.7^{b}	332±8.2^{e}	439±19.5^{c}	384±16.5^{d}	362±32.5^{de}	258±24.7^{f}	676±32.3^{a}	445±28.8^{c}
UOMI, g/d	397±30.9^{cd}	380±14.1^{d}	497±15.7^{b}	513±12.2^{b}	403±31.2^{cd}	426±46.5^{c}	635±30.5^{a}	513±25.4^{b}
CP, g/kg DM	148±5.8^{a}	90±1.9^{b}	79±5.7^{b}	99±4^{b}	138±11.7^{a}	133±5.9^{a}	157±5.8^{a}	98±6.0^{b}
CPI, g/d	185±11^{b}	84±2.5^{e}	91±7.7^{de}	113±4.6^{cde}	131±16.8^{c}	118±13.5^{cd}	253±13.4^{a}	113±6.3^{cde}
a, %	30±3^{a}	18±3^{b}	8±1.6^{b}	13±1.8^{b}	11±1.8^{b}	13±2.1^{b}	31±3.3^{a}	29±5^{a}
b, %	40±2.9^{c}	51±3.7^{abc}	57±2.8^{a}	52±3.1^{ab}	63±2.5^{a}	49±3.9^{abc}	50±3.2^{abc}	42±4.2^{bc}
kd, %/h	10±3^{a}	20±5^{a}	9±2^{a}	12±3^{a}	14±4^{a}	10±3^{a}	20±3^{a}	23±10^{a}
Effective degradability	52±2.9^{b}	53±2.2^{b}	41±1.7^{c}	42±2.6^{c}	50±2.1^{b}	37±2.2^{c}	68±1.5^{a}	55±3.2^{b}
DCPI, g/d	94±3.8^{b}	44±2.7^{de}	37±3.1^{e}	46±3.2^{cde}	68±9.4^{c}	44±6de	172±10^{a}	63±5.7^{cd}
UCPI, g/d	92±9.4^{a}	39±1.8^{d}	54±5.2^{cd}	66±5^{bc}	64±8.6^{bc}	75±8.6^{ab}	81±5.7^{ab}	50±3.1^{cd}
DCPI, g/kg of degraded OM	164±11^{bc}	134±6.9^{cd}	84±5.4^{d}	121±7.9^{cd}	194±21.5^{b}	166±13^{bc}	256±10.9^{a}	142
Synchrony index	0.84±0.02^{a}	0.74±0.04^{abc}	0.67±0.04^{c}	0.70±0.03^{bc}	0.69±0.02^{bc}	0.75±0.03^{abc}	0.80±0.02^{ab}	0.83

OM = organic matter; CP = crude protein; OMI = organic matter intake; CPI = crude protein intake; DOMI = degraded organic matter intake; UOMI = undegraded organic matter intake; UCPI = undegraded crude protein intake; a = soluble fracion; b = degradable fraction; kd = rate constant of degradation; DCPI = degraded crude protein intake.

^{a,b,c,d} Means in rows for each variable with different letter superscripts differ by season (P< 0.05).

Table 4. Correlation coefficients between seasonal climatic variables (rainfall and temperature) and OM and CP extrusa samples, OM and CP degradation parameters

Item	Rainfall, mm		Temperature °C	
	r	Significancy	r	Significancy
OM, g/kg DM	.01	ns	-.21	*
OMI, g/d	-.06	ns	-.30	**
a, %	.35	***	.32	***
b, %	.10	ns	-.03	ns
kd, h	.00	ns	-.11	ns
a+b, %	.24	ns	.10	ns
Effective degradability	.29	**	.10	ns
DOMI, g/d	.08	ns	-.17	ns
UOMI, g/d	-.25	*	-.40	***
CP, g/kg DM	.55	***	.43	***
CPI. g/d	.29	**	.06	ns
a, %	.14	ns	.10	ns
b, %	.00	ns	-.05	ns
kd, h	.02	ns	.02	ns
a+b, %	.14	ns	.04	ns
Effective degradability	.17	ns	.02	ns
DCPI, g/d	.24	*	-.00	ns
UCPI, g/d	.26	**	.17	ns
DCPI, g/kg of degraded OM	.43	***	.29	*
Synchrony index	.16	ns	.17	ns

***(P<.001); **(P<.01); *(P<.05); ns = no significant.

CONCLUSIONS

Sampling date dependence of degraded and undegraded OM and CP intake was observed in this study, presumably because a climatic effect on vegetation and the animals. It appears that goats were able to select diets with a variety of species with synchronized degradation of OM and CP presumably to maintain a relatively constant forage nutrient digestion in the rumen. However it is not clear if goats prefer forage species because their high synchrony of organic matter and crude protein availability in the rumen or select complementary species to obtain a diet with high synchrony. Therefore this point/issue deserves further research. We propose that future studies require further detail on variations in diet, diet quality, and digestive efficiency to properly understand mechanisms of adaptation. Thus, factors such as the role of urea transporters, which control urea transfer from the blood to the gastrointestinal tract and the ammonia receptors which might be involved need to be determined. In addition, use of N^{15} may help to trace kinetics of N transactions between the rumen, blood, saliva and microbial protein to complement this approach.

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