Journal of Animal and Veterinary Advances 10 (21): 2831-2837, 2011
ISSN: 1680-5593

Composition and Quality of Cattle Diet under Extensive Grazing on Grasslands in Northern Mexico

[1,2]Jesus Herrera Corral, [3]Francisco Gonzalez Gonzalez, [4]Oscar F. Carrete Carreon,
[1]Nestor Naranjo Jimenez, [4]Martin E. Pereda-Solis and [1]Yolanda Herrera Arrieta
[1]Instituto Politecnico Nacional, CIIDIR Durango, Sigma 119 Frac. 20 de Noviembre II,
Durango, 34000 Dgo, Mexico
[2]Estudiante del Programa Interinstitucional de Doctorado en Ciencias
Agropecuarias y Forestales de la Universidad Juarez del Estado de Durango
[3]Campo Experimental Valle del Guadiana, Instituto Nacional de Investigaciones
Forestales Agricolas y Pecuarias, Durango, Mexico
[4]Facultad de Medicina Veterinaria y Zootecnia de la Universidad
Juarez del Estado de Durango. Km 11.5 carretera Durango-Mezquital,
34000 Durango, Mexico

Abstract: The sustainable exploitation and management of natural resources requires greater knowledge. Grasslands are complex ecosystems where the interaction of their components rules the preservation of the resource. Grazing is a form to regulate the existence of grasslands and their rational use depends on the knowledge that integrates the management. Thus, the objective of this study was to determine the botanical and chemical composition of the diet selected by cattle grazing on open grassland in Northern Mexico. Voluntary forage intake, digestibility, crude protein and detergent fiber were calculated. A total of 65 species, 53 genera and 16 families are present in the grasslands of the study area. The families with the greatest number of genera were: Gramineae (23), Compositeae (11), Leguminaseae (3) and Convolvulaceae (3). The diet selected by cattle in the rainy season is composed by plants from 10-12 families, 10 genera and 11 species of grasses, 27 genera and 28 species of herbaceous plants. The diet for the dry season was composed by 4 families, 4 genera and 4 species of grasses; 3 genera and 3 species of herbaceous plants. In general, the diet was composed of 40 species which corresponds to 61.5% of the species found in the grassland. Voluntary intake was 2.51% of live weight for the rainy season and 2.16% for dry season. The content of crude protein and digestibility in the diet was 7.18, 6.13, 65.18 and 63.4% for the rainy and dry season, respectively. The analysis of fibers by season showed significant differences ($p<0.05$) and no significant differences were found between animals and days of sampling by season.

Key words: Voluntary intake, floristic composition, grassland, grazing, animal, Mexico

INTRODUCTION

The nutrition of ruminants under extensive grazing is a complex process with special characteristics and problems. Determination of nutritive value and digestibility is difficult because animals select their diet from various combinations of species and plant parts (Zemmelink, 1980). But the most critical factor in nutritional requirements of ruminants under grazing is the lack of knowledge of voluntary intake (Allison, 1985). Voluntary intake should be determined in order to predict the proportions of requirements which can meet the diet that cattle consume in the rangeland and thus establish the necessary supplementation (NRC, 1984). Minson (1990) defines the voluntary intake as the amount of dry matter consumed each day when animals are supplied with feed in excess. In livestock production, profits depend on the ability to maximize feed intake since feed costs can reach up to 70% of production cost and daily feed intake is the result of a great variety of stimuli of the central nervous system.

Minson (1990) mentions that animal consumption under grazing is controlled by own factors of the animal, fodder and environment in which selectivity and forage availability are involved. In the rangeland forage accessibility, distance to water and temperature fluctuations appear to be the most important constraints for consumption.

The grazing system influences the quality of diet and hence in consumption because when the intensity of

Corresponding Author: Martin E. Pereda-Solis, Apartado Postal 291, Durango, 34000 Dgo, Mexico

grazing is increased, the cattle has less opportunity to select the diet due to the fact that speed of change of species and preferred plant parts are increased (Allison, 1985). The season of the year, the animal's physiological condition, the nutrition value of plants, plant composition, the land orography are some of the factors that influence the preference of cattle for the plant species (Allison, 1985).

The floristic composition of grasslands in Northern Mexico has been modified by grazing and the introduction of invasive species. Given the characteristics of the floristic composition, the diversity of species, the growth cycles, the nutritional value and palatability of the diet composition of the grazing cattle is modified.

These factors affect not only the nutritional status of the animal but also the dominance and nutritional value of the species through selective grazing (Soder *et al*., 2009). Research in the area of diet selection and preference is scarce and mainly limited to a simple model of some grass species, regardless of species from other plant families.

Knowledge of grazing habits and preference for certain species in the rangelands are essential in designing more effective grazing systems that allow planning and development of practices to improve them.

In addition to this, chemical analysis of forage to determine their nutritional value is useful to identify deficiencies and structure programs of supplementation of grazing animals during critical periods.

Research on diet selection has allowed the characterization of forage preferences and nutritional value provided by the grass species under study (Kirby and Parman, 1986). These studies appreciate the native grasses as a fundamental part of the diet of cattle but suggest the possibility of extending the studies of invasive grasses and herbs as dietary components and nutrient content.

The objective of this study was to determine the botanical composition of the grassland and diet as well as the voluntary intake and quality of the diet selected by esophageal fistulated cattle, grazing on an open rangeland under extensive grazing.

MATERIALS AND METHODS

Description of the study area: This study was conducted on the private property el Sagal with a 2000 ha area and is located in the municipality of Durango, Mexico between 24°09' and 24°13'N and 104°16' and 104°20'W at an altitude of 1950 masl. The area has a semiarid climate of the type BS1 kw (w) (e) and an average annual temperature of 16°C. Average annual rainfall is from 450-550 mm with a rainfall regime in June-September (summer). The soil is from *in situ* origin derived of igneous rock from sandy to frank texture, granular structure from medium to rapid internal drainage, a moderately slow surface run off and pH of 6.5-7.5. The topography is flat with low ridges and low hills with slopes of 0-10%. The vegetation consists of native grasses of the genus *Bouteloua*, along with *Botrhriochloa barbinoidis*, *Heteropogo contortus*, *Aristida* sp., *Muhlenbergia* sp., *Trachypogon secundus*, *Enneapogon desvauxi*, *Lycurus phleoides*. The shrub layer is composed of *Opuntia* sp., *Acacia tortuosa*, *Prosopis leavigata*, *Celtis pallida* and *Mimosa biuncifera*. The grazing system practiced is the continuous system with a stocking rate of 5 ha per animal unit per year.

Vegetation sampling: Vegetation sampling was carried out in October 2008 and May 2009 in the study area. To conduct the samplings the methods of line intercept (Canfield, 1941) and forage production square meter were used. With the procedure proposed by Canfield it was measured the clipping at ground level of plants along a tape measure, measuring the space occupied by each species as well as the bare soil. Transects used in this study are permanent they are 20 m long and a 50 m separation between lines. The forage production square meter method was applied laying a quadrant of 1×1 m size randomly in each study site adjacent to each line canfield. In this sample the number of species was counted and was clipped at ground level. The collected biomass was separated by species, placed in paper bags and dried in an oven at 30°C until reach constant weight to determine dry matter production per hectare. As a rule, samples were avoided at 200 m of water sources for the cattle. Parameters obtained were density, dominance and frequency of species in order to determinate their Value Index of Importance (IVI) also forage production was determined.

Esophageal samples of the diet consumed: In October 2008 and May 2009 (times of abundance and scarcity of fodder) the diet samples were collected during 5 consecutive days for which three steers with esophageal fistula were used with an average weight of 440 kg they were given a conditioning period of 10 days on the range. Samplings were carried out in the morning (700-800) after removal the canula and place the collection bags with harnesses. The bovines were given the diet during the night to prevent regurgitation of feed and the contamination of the sample. The samples were dried at 50°C and ground in a Wiley mill with 1 mm mesh. Once dried and ground were stored in sealed containers and placed at room temperature until analysis.

Determination of botanical composition of the diet: During the study of vegetation plants species (grasses and other families) were collected as reference samples for the micro-histological study. The botanical composition of the diet was determined using observational micro-histological techniques of epidermis. To assemble reference slides and esophageal samples the technique described by Pena and Habib was used.

Portions of esophageal samples to carry out the assembly of four slides per sample were taken which were then viewed through a stereomicroscope. With the reading of the slides the number, frequency and proportion of species that appear in the diet were obtained. The fragments are placed in an aqueous solution of commercial detergent and taken to boiling temperature for 30 min to hydrate and soften tissues. Fragments were subsequently included in commercial hypochlorite to separate cellular components. Epidermal cuts are stained with safranine and excess of water is removed passing the cuttings by an aqueous solution of alcohol at different concentrations (30, 50, 70, 95 and 100%). Samples were mounted in resin.

The anatomical observations were made with a light microscope at 10 and 40X magnification. Microphotographs were taken. The Ellis (1979) method was use.

Determination of the chemical composition of the diet: To another portion of the sample obtained from fistulated animals the fiber content proposed by Van Soest was determined in duplicate, according to the techniques described by Tejada. This analysis was complemented by crude protein measurements from the determination of nitrogen content using the method Kjendhal.

The samples of the botanical and chemical composition of the diet were grouped by sampling sites. The results obtained were subjected to analysis of variance under a completely randomized design, the comparison of means to detect differences between samples were made using the Student t-test.

Estimation of voluntary intake of forage: For the estimation of voluntary intake three esophageally fistulated bovine which were given via the fistula, chromium oxide impregnated in paper. The rate used per animal was 20 g day^{-1}. The chromium oxide was administered at 700 and 1600 h, 10 days before sampling of feces and during the sampling period. Collection of feces was performed at 700 and 1600 h for 5 consecutive days. The determination of chromium in feces was carried out by analysis of atomic absorption spectrophotometry. To determine the Total of feces Produced (THP) the following equation was used:

$$THP = \text{Daily rate of the indicator/feces indicator}$$

Samples of the diet were used to estimate the indigestible fraction of the diet, obtained by esophageal fistula, the *in vitro* method developed by ANKOM Technology (2008) was applied to the samples.

RESULTS AND DISCUSSION

Botanical composition of the grassland: The land topography consists of small hills and hollows as well as the presence of igneous rock favors the variation of microhabitats which allow the establishment of a considerable diversity of species this coupled with the semi-arid climatic conditions reflect a good floristic diversity. Thus a total of 65 species, 53 genera and 16 families are present in the grassland of the study area (Table 1 and 2). The families with higher number of genera

Table 1: Floristic inventory of the grassland

Scientific name	Quality	Condition
Bouteloua gracilis	Excellent	Desirable
Bouteloua curtipendula	Excellent	Desirable
Bouteloua radicosa	Good	Desirable
Bouteloua simplex	Poor	Undesirable
Bouteloua repens	Good	Desirable
Lycurus phleoides	Good	Less desirable
Aristida divaricata	Regular	Less desirable
Hilaria cenchroides	Good	Less desirable
Panicum obtusum	Regular	Less desirable
Muhlenbergia repens	Good	Less desirable
Chloris submutica	Regular	Undesirable
Buchloe dactyloides	Excellent	Desirable
Cenchrus myosuroides	Poor	Less desirable
Chloris virgata	Regular	Undesirable
Sporobolus airoides	Good	Less desirable
Bothriochloa barbinodis	Regular	Less desirable
Andropogon saccharoides	Regular	Less desirable
Muhlenbergia rigida	Regular	Less desirable
Muhlenbergia emersley	Poor	Less desirable
Stipa eminens	Good	Less desirable
Setaria parviflora	Good	Less desirable
Setaria grisebachii	Regular	Undesirable
Heteropogon contortus	Regular	Less desirable
Aristida ternipes	Regular	Less desirable
Aristida pansa	Regular	Less desirable
Aristida adscensionis	Poor	Undesirable
Elionurus barbiculmis	Good	Desirable
Melinis repens	Regular	Undesirable
Trachypogon spicatus	Good	Less desirable
Setaria macrostachya	Good	Less desirable
Eragrostis intermedia	Good	Less desirable
Muhlenbergia minutissima	Poor	Undesirable
Muhlenbergia dubia	Regular	Less desirable
Pennisetum villosum	Regular	Less desirable
Eriochloa acuminata	Regular	Less desirable

Table 2: Composition of the cattle diet during the rainy season

Family/species	Average	Frequency (%)
Gramineae	-	100.00
Bothriochloa barbinodis	30.86	100.00
Bouteloua curtipendula	9.09	86.67
Bouteloua gracilis	10.70	93.33
Chloris virgata	5.63	71.11
Elionurus barbiculmis	7.92	68.89
Heteropogon contortus	1.42	31.11
Melinis repens	0.18	13.33
Schizachyrium sanguineum	1.98	26.67
Setaria parviflora	0.08	6.67
Trachypogon secundus	3.72	31.11
Eriochloa acuminata	0.43	53.33
Commelinaceae	-	41.00
Commelina sp.	1.65	51.11
Compositae	-	80.00
Tithonia tubiformis	0.40	13.33
Simsia amplexicaulis	0.54	24.44
Dyssodia porophyllum	2.82	48.89
Perymenium sp.	1.61	24.44
Viguiera linearis	2.01	48.89
Eupatorium sp.	0.07	6.67
Sanvitalia procumbens	0.07	6.67
Bidens sp.	0.13	11.11
Parthenium sp.	0.25	11.11
Verbesina sp.	0.06	6.67
Malvaceae	-	86.60
Sphaeralcea angustifolia	5.51	86.67
Leguminosae	-	73.30
Crotalaria pumila	3.87	73.33
Macroptilium sp.	0.20	33.33
Phaseolus sp.	0.13	11.11
Loasaceae	-	55.30
Mentzelia hispida	1.46	48.89
Loganiaceae	-	13.33
Buddleja scordioides	0.25	13.33
Polygalaceae	-	6.60
Polygala sp.	0.09	6.67
Solanaceae	-	26.60
Physalis sp.	0.64	33.33
Convolvulaceae	-	24.30
Ipomoea stans	0.38	24.44
Verbena sp.	0.87	42.22
Phyla nodiflora	2.50	44.44
Acanthaceae	-	13.30
Dyschoriste decumbens	0.14	6.67
Agavaceae	-	20.00
Manfreda scabra	0.41	13.33
Portulacaceae	-	11.00
Portulaca oleracea	0.25	33.33
Rubiaceae	-	11.00
Crussea sp.	0.52	11.11

were: Poaceae (23), Asteraceae (11), Leguminosae (3) and Convolvulaceae (3). In the grasses the outstanding species are *Bouteloua gracilis*, *B. curtipendula*, *Bothriochloa barbinodis*, *Heteropogon contorus*, *Melinis repens*, *Chloris virgata* and *Muhlenbergia minutissima* while in the herbaceous plants the conspicuous species are *Viguiera linearis*, *Sanvitalia procumbens* and *Gomphrena decumbens*.

In regard to the grasses six desirable species were found, 22 less desirable and eight undesirable, considered with a regular to excellent forage quality.

Table 3: Relative frequency, density and dominance and Importance Value Index (IVI) of the species in open grassland

Species	Relative frequency	Relative density	Relative dominance	I V I
Aristida adscensionis	1.49	1.73	0.91	4.13
Aristida divaricata	0.50	0.14	0.41	1.05
Aristida pansa	1.00	0.43	0.60	2.03
Bothriochloa barbinodis	7.96	5.77	6.79	20.52
Bouteloua curtipendula	10.45	7.36	9.13	26.94
Bouteloua gracilis	7.96	2.74	2.11	12.82
Bouteloua repens	0.50	0.14	0.46	1.11
Bouteloua radicosa	3.48	1.01	1.23	5.73
Chloris virgata	10.45	18.90	16.66	46.01
Cynodon dactylon	0.50	0.43	0.49	1.42
Elionurus barbiculmis	0.50	0.29	1.70	2.48
Eragrostis intermedia	1.99	3.03	2.12	7.14
Eriochloa acuminata	2.99	4.04	3.75	10.77
Heteropogon contortus	14.93	20.35	19.22	54.50
Melinis repens	15.42	19.77	19.06	54.25
Muhlenbergia minutisima	10.45	10.25	12.06	32.75
Muhlenbergia dubia	1.49	0.58	0.61	2.68
Muhlenbergia emersleyi	0.50	0.14	0.14	0.78
Panicum obtusum	0.50	0.14	0.08	0.73
Setaria grisebachii	2.49	1.44	0.87	4.80
Setaria macrostachya	0.50	0.14	0.12	0.76
Setaria parviflora	1.99	0.58	0.47	3.04
Trachypogon spicatus	0.50	0.14	0.91	1.55

Table 4: Composition of cattle diet during the dry season

Species	Average	Frequency
Solanum elaeagnifolium	65.01	100
Buddleja scordioides	6.71	80
Bouteloua curtipendula	8.12	80
Bothriochloa barbinodis	4.25	40
Elionurus barbiculmis	7.34	80
Trachypogon spicatus	2.88	40
Perymenium parvifolium	5.67	60

Taking into account the Importance Value Index (IVI) the grassland was classified by the association of species as *Heteropogon-Melinis* (Table 3) important datum given that in 1979 it has been classified by the *Bouteloua-Bothriochloa* association. The production of grasses and herbaceous species was estimated in 3875 and 526 kg ha^{-1}, respectively.

Botanical composition of diet: The botanical composition of steer diet by season is shown in Table 2 and 4. The diet selected by cattle in the rainy season is composed by plants of 10-12 families, 10 genera and 11 species of grasses, 27 genera and 28 herbaceous species. The diet of the dry season consisted of 4 families, 4 genera and 4 species of grasses; 3 genera and 3 herbaceous species. In general, the diet was composed by 40 species which corresponds to 61.5% of species of the Sagal. There were significant differences ($p<0.05$) in the consumption of species between seasons. The micro-histological study revealed that the cattle diet during the rainy season consisted of 72% grasses being the species *Bothriochloa barbinodis*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Chloris virgata*,

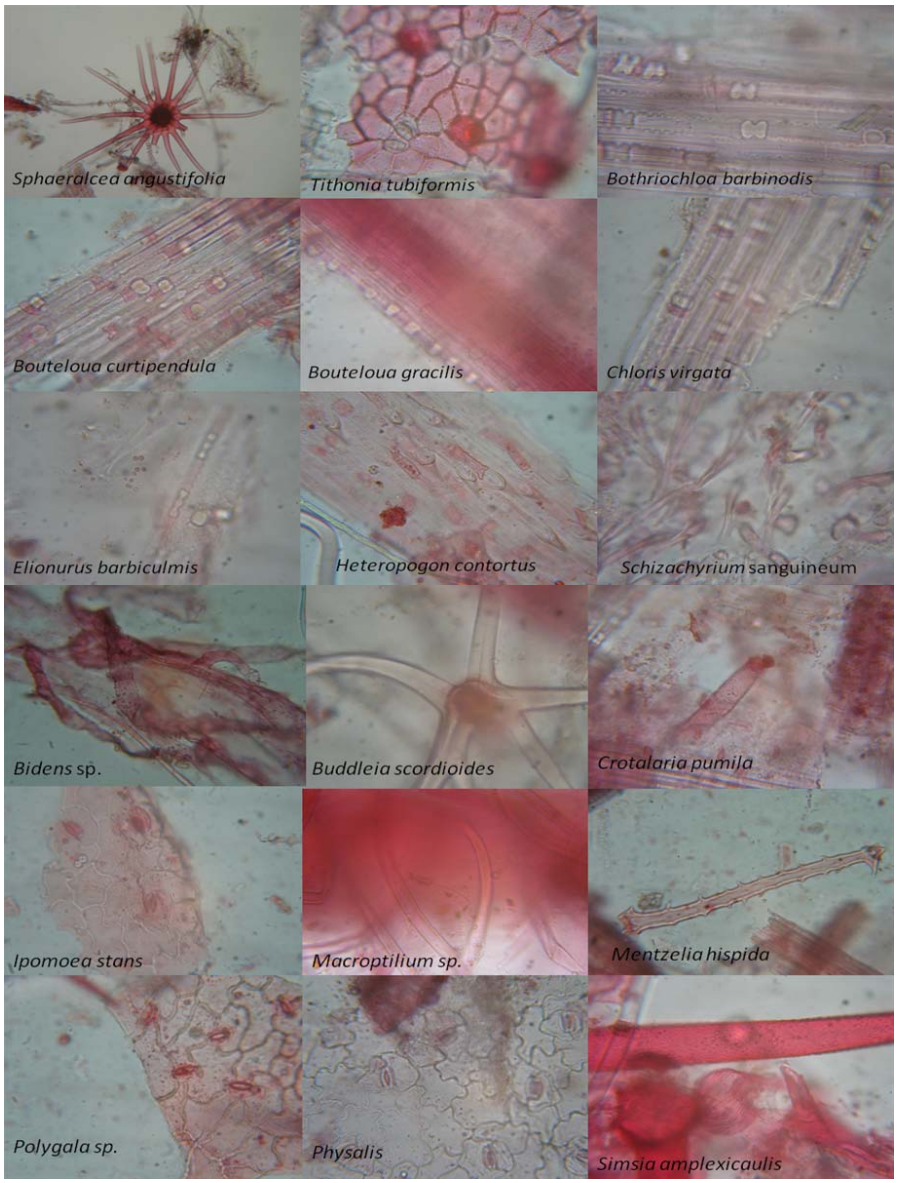

Fig. 1: Anatomical structures of the main species eaten by livestock in the rainy season

Elionurus barbiculmis and *Heteropogon contortus* the most consumed. The herbaceous species that had higher consumption were *Dyssodia porophyllum*, *Viguiera linearis*, *Sphaeralcea angustifolia*, *Crotalaria pumila*, *Mentzelia hispida*, *Conmelina* sp., *Simsia amplexicaulis*, *Perymenium* sp., *Verbena* sp., *Phyla nodiflora*, *Physalis* sp. and *portulaca oleracea* (Table 2 and Fig. 1).

During the dry season the importance of grasses is reduced by passing the consumption of 72% in the rainy season to 28.6%, finding that the diet in the dry season consists mainly of *Solanum elaeagnifolium* (Table 4). Voluntary intake (CV) showed significant differences ($p<0.05$) between seasons. The animals showed a consumption of 2.51 of live weight for the rainy season and 2.16 for the dry season.

The highest content of crude protein in the diet is found in the rainy season (7.18%) and the lowest CP content in the dry season (6.13%). Cattle selected diets with higher digestibility in rainy seasons (65.18%) than in dry seasons (63.4%).

The analysis of fibers by seasons showed significant differences ($p<0.05$) in all of their components (Table 5). There were no significant differences between animals and days of sampling by season. The diet selection by

Table 5: Voluntary intake and chemical composition of the diet selected by cattle in two grazing seasons

Season	Voluntary intake	Crude protein	Neutral detergent fiber	Acid detergent fiber	Cellulose	Lignin
Rainy	2.51[a]	7.18[a]	68.3[a]	51.30[a]	39.5[a]	11.6[a]
Dry	2.16[b]	6.13[b]	76.4[b]	63.38[b]	47.9[b]	15.1[b]

Letters indicate the significant differences ($p>0.05$)

cattle showed differences between sampling seasons. Grasses composed the basic diet of cattle during the summer season this seasonal behavior was likely due to the fact that in this season the greatest period of rainfall is present which is related to an increase in the production of succulent green material and in the quality of grasses that perhaps favored a higher consumption of these species. Grasses were selected to a lesser extent in the dry season when their production and quality decreased affecting consumption.

Melinis repens consumption is reduced in rainy seasons and zero in dry season. Low consumption can be explained by the availability of other more succulent species for cattle than by the effect of availability and this means that grazing cattle select only certain species in determined seasons and in a different proportion to that found in the rangeland (Kirby and Parman, 1986). Knowledge of selectivity and grazing season of different species by cattle may contribute to define grassland management strategies for a better production and a minor deterioration. It is important to note the presence of *Melinis repens*, invasive species that for their aggressiveness displaced native grassland species causing changes in the association of dominant species, passing from *Bouteloua-Bothriochloa* to *Heteropogon-Melinis*.

Although, cattle do not usually select their diet in the same proportion of species in the rangeland and that the general trend of cattle is to select grasses to constitute the major portion of their diet in this study, the species most selected in the dry season were herbaceous, mainly *Solanum elaeagnifolium*, species reported for the same season by Hakkila *et al*. (1987). This herbaceous species and those reported as the most consumed species in this study should be included in the list proposed by Chavez to be studied because they may represent a potential fodder for livestock.

Higher consumption of herbaceous species during the dry season may be due to various factors such as availability and accessibility of the resource (Penning *et al*., 1991; Soder *et al*., 2009), the demand of nutrients (Weston, 1996; Fryxell, 2006) and palatability. In this regard, Mayland *et al*. (2005) state that grazing animals have patterns of preferences which can increase the consumption of pastures during the night because the sugar content in them increases during the day, potentially making them more palatable. This might suggest that in consumption studies the sampling time should be extended to differ from what was found herein.

Annual herbaceous species contributed about 28% of the cattle diet during the rainy season, a figure that is similar to that obtained by Sosa while during the dry season shrubs and herbaceous perennials contributed to the diet 77% which becomes important as they are available when grasses are scarce, besides that herbaceous species have a good nutritional value (Pfister and Melechek, 1986). Chavez found different consumption of herbaceous plants between seasons in open grasslands and Sosa did not observe differences in the consumption of herbaceous plants between seasons in tropical grassland where seasonal changes are not as drastic and therefore, the presence of herbaceous species can be homogenous throughout the year. This shows that animals can develop preferences and select diets according to vegetation present in the grazing area and also that in animals there are diets of different vegetal composition but with similar content of nutrients in a same season.

The diversity of species, their availability, phenology and palatability affect the chemical composition of the diet selected by ruminants also the effect of grazing intensity can be included due to the fact that there is evidence that the cutting with a 30 days frequency increases the protein content and conversely when the intensity is given every 5 or 10 days, fact that explains the significant differences ($p<0.05$) in the crude protein content of the diet obtained by cattle in sample periods. The concentration of protein.

The concentration of protein obtained in the diet during the rainy season is in the range obtained by Chavez in the open rangeland located in Chihuahua, Mexico who at the stage of maturity determined a concentration of 6% by 7.18% found in this study but differ in the concentration obtained in the dormancy stage in which they obtained a 4% against 6.13% found in this research. This content could be due to consumption of herbaceous plants found in the diet. The found protein content suggests that deficiencies that this nutrient can have are mainly due to consumption reduction and the available forage resource.

The diet selected by fistulated cattle that had higher digestibility was that of the rainy season, when consumption of grasses was higher than other species. This value decreases as advancing stage of maturity of vegetation. In general, the low digestibility in the diet of animals is often associated with the consumption of plants with high levels of lignification which occurs during the period of maturity of vegetation.

Researches of diet selection and preferences are scarce and mainly limited to a simple model of two species. Control of dry matter intake by grazing ruminants is too complex and that is the result of a dynamic combination that includes the animal, vegetable rumen and negative and/or positive factors.

Control of dry matter intake by grazing ruminants is too complex since it is the result of a dynamic combination that includes the animal, rumen and negative and/or positive vegetable factors (Soder *et al*., 2009). The CV reported in this study coincides with those reported by Hakkila *et al*. (1987) and Chavez and Gonzalez in open grassland and they mainly emphasize on consumption in the dry season where low consumption is the main factor by which nutritional needs for pregnant cows are not met but indeed for heifers and calves.

CONCLUSION

Grasses are part of the diet in a 72% during the rainy season and decrease to 28% in dry season while other legume and composed species increase their contribution to the diet. The availability of species that comprise the grassland determines the diet of livestock that adjust their selection based on nutritional needs during the different seasons. As a result, grasses play an important role during the rainy season while shrubs and herbaceous perennials provide in a greater proportion their nutritional value in the diet during the dry season.

Animals can develop preferences and select diets according to the vegetation in the grazing area and also animals from the same herd and in the same season can select diets of different plant composition but with similar nutrient content and depends on consumption to meet the needs of protein and energy.

It is important both knowledge of the floristic composition of rangeland and selectivity and grazing season of different species by cattle to contribute in the definition of grassland management strategies for an increased production and a lower deterioration.

REFERENCES

ANKOM Technology, 2008. Procedures for fiber and *in vitro* analysis. http:/www.Ankom.com.

Allison, C.D., 1985. Factor affecting forage intake by range ruminants: A review. J. Range Manage., 38: 305-331.

Canfield, R.H., 1941. Application of the line interception method in sampling range vegetation. J. For., 39: 388-394.

Ellis, W.C., 1979. Determinants of grazed forage intake and digestibility. J. Dairy Sci., 61: 1828-1840.

Fryxell, J.M., 2006. Forage quality and aggregation by large herbivores. Am. Naturalist, 138: 478-498.

Hakkila, M.D., J.L. Holechk, J.D. Wallace, D.N. Anderson and M. Cardenas, 1987. Diet and forage intake of cattle on desert grassland range. J. Range Manage., 40: 339-342.

Kirby, D.R. and M. Parman, 1986. Botanical composition and diet quality of cattle under o short duration grazing system. J. Range Manage., 39: 509-512.

Mayland, H., H.D. Mertens, T. Taylor, J. Burns and D. Fisher *et al*., 2005. Diurnal changes in forage quality and their effects on animal preference, intake, and performance. Proceedings of the California Alfalfa Symposium, Dec. 12-14, University of California, Davis,Visalia CA. USA., pp: 1-8.

Minson, J.D., 1990. Forage in Ruminant Nutrition. National Academy Press San Diego, CA.

NRC, 1984. Nutrient Requirements of Beef Cattle. National Academy Press, Washington, DC., pp: 78.

Penning, P.D., A.J. Person, R.J. Orr and T.T. Treacher, 1991. Intake and Behaviour response by sheep to changes in sward characteristics under continuous stocking. Grass Forage Sci., 46: 15-28.

Pfister, J.A. and J.C. Melechek, 1986. The voluntary forage intake and nutrition of goat and sheep in the semi-arid tropics of northeastern Brazil. J. Anim. Sci., 63: 1078-1086.

Soder, K.J., P. Gregorini, G. Scaglia and A.J. Rook, 2009. Dietary selection by domestic grazing ruminants in temperate pasture: Current state of knowledge, methodologies, and future direction. Rangeland Ecol. Manage., 62: 389-398.

Weston, R.H., 1996. Some aspects of constraint to forage consumption by ruminants. Aust. J. Agric. Res., 49: 175-197.

Zemmelink, G., 1980. Effect of Selective Consumption on Voluntary Intake and Digestibility of Tropical Forage. Center for Agricultural Publishing and Documentation, Wageningen, DC.