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Agronomic and nutritional characteristics of three grass species in the southern region of Mexico

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ABSTRACT

The study was conducted to evaluate the agronomic and nutritional characteristics of 3 grass species in the Zacazonapan municipality in the southern region of Mexico for one-year period. Three pastures were used, with a different grass species established in each of them: *Cynodon plectostachyus, Paspalum notatum* and *Brachiaria decumbens*. The agronomic variables evaluated were: net forage accumulation (NFA), and the amounts of stems, leaves, and live and dead matter. Also evaluated were protein content, neutral detergent fiber (NDF), acid detergent fiber (ADF), digestibility of organic matter (dOM) and metabolizable energy (ME). A randomized block design was used, and data was analyzed using variance analysis, with the Tukey's test used to compare treatment means. There were significant differences among the 3 grass species evaluated, as well as among the evaluation periods (June 2009 to May 2010).

In relation to the nutritional variables, there were significant differences among the evaluation periods, but not among the 3 grass species evaluated. It was concluded that the nutrient contents of the grasses were similar and the accumulation of forages were greater during the time period with more precipitation.

Key words: Crude protein, Net forage accumulation, Nutritional quality, Tropical grasses

Tropical grasses are the primary nutrient resource for cattle production in the tropics and they provide low-cost nutrients to cattle (Elizondo and Boschini 2003). However, during a certain period of the year, supply and quality of dry matter are insufficient for meeting the minimum nutrient requirements of grazing cows. Tropical grasses have a high structural carbohydrate content, but they are low in soluble carbohydrates, and have less than 7% protein (Hernández *et al.* 2005). Production by ruminants fed with tropical grasses is limited by low digestibility and minimal dry matter intake (Bargo *et al.* 2002). Indeed increasing the digestibility of potentially digestible fractions or the rate of passage of non-digestible fractions are strategies for increasing the intake of digestible nutrients from tropical grasses (Pinzón and Montenegro 2001).

Milk production is important in Zacazonapan municipality in the State of Mexico. This production occurs primarily in pastures of native grasses and some introduced grasses. However, during a certain period of the year, it is necessary to supplement the diet of dairy cows with balanced feed, since pastures do not produce enough quantity or quality to maintain milk production. Few studies were conducted in relation to the agronomic and nutritional characteristics of the region's pastures, but still there is paucity of information. Thus, the objective of this study was to determine the agronomic characteristics and nutrient content in pastures with 3 grass species, and the effect of the time period, during a year-long evaluation in the Zacazonapan municipality.

MATERIALS AND METHODS

Experimental site: The study was conducted in the municipality of Zacazonapan, Mexico, located between 19º 00´ 17" and 19º 16´ 17" N and 100º 12´ 55" and 100º 18´ 13" O. The site is also located at an altitude of 1,470 m and the annual average temperature is 23ºC (Carta Estatal de Regionalización Fisiográfica 1980). The study was conducted from June 2009 to May 2010 in small-scale milk production units.

Characteristics of pastures: Three pastures were used, each having an approximate land area of 4 ha, with continuous grazing of multiparous cows. In each pasture a different grass species was established, with the following species predominating: *Cynodon plectostachyus* (8 Holstein cows /ha), *Paspalum notatum* (8 Zebu × Brown Swiss cows /ha) and *Brachiaria decumbens* (8 Zebu × Brown Swiss cows/ha). These were monophyte pastures. *Paspalum*

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notatum is a native species to the region and it grows naturally in fields. *Cynodon plectostachyus* is an introduced species that was planted approximately 10 years prior to this experiment and *Brachiaria decumbens* was planted 3 years prior to this experiment, and both species have adapted to the region. The agronomic variables evaluated were: net forage accumulation (NFA), leaf amount (LA), stem amount (SA), dead matter amount (DMA), live matter amount (LMA), and height of pasture (HP).

Height of pasture: Monthly measurements of the pastures were made, using the rising plate technique (Hodgson 1994). Measurements were taken every 20 steps, and 20 zigzag measurements were taken in each pasture.

Net forage accumulation: To measure the net forage accumulation, 6 exclusion cages were randomly placed in each pasture, (Hodgson 1994). The cages were adapted to the growth and size of the grass, with dimensions of 1.0 m high, 1.20 m long and 0.60 m wide. Every 28 days the grass was cut inside and outside of each cage, using a 0.25 m^2 metal quadrant for cutting the forage inside of it. On day 0 of the measurement, the cage was randomly placed in the pasture; later, 5 measurements of height were made next to the cage, taking care that the characteristics of the measurement area were similar to those of the excluded area. The 0.25 m^2 metal quadrant was placed near the exclusion cage and the forage inside the quadrant was cut at ground level using shearing scissors. On day 28, the cage was removed, the 0.25 m^2 quadrant was positioned and the forage inside the quadrant was cut to determine the NFA. This procedure was repeated every 28 days during the year of evaluation. The NFA was calculated with the following formula:

$$\text{NFA (kgDM/ha)} = \text{DMi} - \text{DMf}$$

where NFA, net forage accumulation (kg DM/ha); DMi, initial average weight outside the cage on day 0 (kg DM/ha); DMf, final average weight inside the cage on day 28 (kg DM/ha).

Amount of live and dead matter: Sample (25 g) was weighed, and the live matter was separated from the dead matter, and each was weighed. Green-colored matter was considered to be live matter, and non-green-colored matter was considered to be dead matter.

Leaf and stem amounts: A sample of leaf and stem amounts was taken from each exclusion cage in each pasture; a compound sample of the cages was prepared; and 25 g was weighed. Then the stems were separated from the leaves, and each was weighed separately.

Chemical analysis of grasses: Chemical analysis was performed on 6 samples/pasture, with an approximate weight of 50 g of dry matter that had been collected using the simulated grazing technique. This sampling was carried out every month from June 2009 to May 2010. The samples were dried in an oven at 60°C until a constant weight was obtained; the matter was then ground, and the digestibility of the organic matter (dOM) was determined using the Daisy method (Ankom Technology 2004). Nitrogen content was determined using the Kjeldahl method (AOAC 1990) and results were multiplied by a factor of 6.25 (AFRC 1993) to obtain the crude protein (CP) content. The neutral detergent fibre (NDF) and acid detergent fibre (ADF) contents were determined using the ANKOM method with the technique from Van Soest *et al.* (1991). The metabolizable energy (ME) of each grass species was calculated using the formula AFRC (1993).

$$\text{ME (MJ/kg DM)} = \text{(dOM)(0.0157)}$$

where ME,metabolizable energy (MJ/kg DM); dOM, digestibility of organic matter (g/kg DM).

Experimental design: A random complete block experimental design was used (Steel and Torrie 1997) to compare results among the different pastures (blocks) and to determine the effect during the period evaluated (evaluation months). The general linear model was: $Y_{ij} = \mu+t_i+B_j+e_{ij}$; where: Y_{ij}, treatment response variable; μ, overall mean; t_i, effect due to the period (i; 1,2, 3…12); B_j, effect due to the block (j, 1, 2, 3); eij, random error. With the data collected, a variance analysis was conducted using Minitab V 14 (2003); and when significant differences were observed, Tukey's test was used ($P \leq 0.05$).

RESULTS AND DISCUSSION

The climate in the area studied is classified as Awo (W) (i´) g, or semi-warm, sub-humid with summer rains, minimal fluctuation and ganges-type progression (García 1988).

Agronomic characteristics of grasses: Dry matter (DM) yields per pasture (Table 1) were different ($P \leq 0.05$) among species (blocks) and periods of evaluation (months of the year). The grass species with the greatest NFA was *B. decumbens,* and the one with the lowest NFA was *P. notatum*, since *Brachiaria* and *Cynodon* were introduced species and their dry matter yields were greater than those of native grass species such as *P. notatum*. Moreover, they are managed differently, since *Cynodon* and *Brachiaria* were fertilized with approximately 200 kg of urea/ha/year and producers eliminated unwanted weeds, leaving both pastures without any competition from other species, while in the pasture of *P. notatum* producers did not fertilize and did not eliminate weeds. The NFA for *Cynodon* was favored by the management practices used in the pastures, since forage production was greater than that reported by Macedo *et al.* (2008), with 8,426 kg DM/ha and greater fertilizer and control of weeds through the use of herbicides. This indicated that this introduced species adapted to the local conditions. Macedo *et al.* (2003) reported that this particular species, once established, is persistent and adapts to different environments. In the case of *Brachiaria*, reports from Rincon *et al.* (2008) for NFA (4,580 kg DM/ha) indicated that dry matter yields were inferior to those observed in this study. Here, we also observed that management practices and environmental conditions favored higher yields.

The leaf and stem amounts (Table 1) varied among the grass species studied ($P \leq 0.05$), with the lowest production in *Paspalum notatum*. The amount of live and dead matter

Table 1. Agronomic variables of the three grass species in small-scale milk production units in the southern part of Mexico

Variable	*C. plectostachyus*	*P. notatum*	*B. decumbens*	SEM	P ≤0.05 (Species)	P ≤0.05 (Period)
NFA (kg DM/ha/month)	847.3[b]	535.9[c]	942.3[a]	112.69	*	*
NFA (kg DM/ha/annual)	10 168	6 431	11 067	-	-	-
LA (kg DM/ha)	275.37[b]	168.80[c]	308.53[a]	55.65	*	*
SA (kg DM/ha)	148.27[a]	99.14[b]	159.80[a]	17.58	*	*
LMA (kg DM/ha)	313.50[a]	192.92[b]	344.45[a]	60.24	*	*
DMA (kg DM/ha)	110.14[a]	75.02[b]	128.70[a]	18.49	*	*
PH (cm)	21.21[a]	9.07[c]	13.74[b]	1.35	*	*

Different literals among the rows indicate significant differences (P ≤0.05); *Significant P ≤ 0.05; NFA, net forage accumulation; LA, leaf amount; SA, stem amount; LMA, live matter amount; DMA, dead matter amount; PH, pasture height; SEM, standard error of the mean.

Table 2. Chemical composition and digestibility of average annual organic matter from three grass species

Variable	*C. plectostachyus*	*P. notatum*	*B. decumbens*	SEM	P ≤ 0.05 (Species)	P ≤ 0.05 (Period)
CP (g/kg DM)	111.92	108.68	111.63	12.63	ns	*
NDF (g/kg DM)	606.00	658.00	626.30	43.28	ns	*
ADF (g/kg DM)	378.70	399.50	379.30	34.17	ns	*
dOM (g/kg DM)	578.8	569.4	568.9	2.85	ns	*
ME (MJ/kg DM)	9.08	8.94	8.93	0.44	ns	*

Different literals among the rows indicate significant differences (P ≤0.05); ns, not significant; *significant P ≤ 0.05; CP, crude protein; NDF, neutral detergent fibre; ADF, acid detergent fibre; dOM, digestibility of organic matter; ME, metabolizable energy; SEM, standard error of the mean.

was greater in the pasture with *Brachiaria decumbens* (P≤0.05), and the lowest production was in *Paspalum notatum*, since this grass species is short and thus, dead matter does not accumulate in the lower part (Avilés *et al.* 2008).

Physical-chemical characteristics of grasses: The physical-chemical characteristics (Table 2) of the 3 grass species studied were similar (P>0.05). However, there were differences among the months evaluated (P≤0.05). The crude protein contribution in the three species was above that reported for the same species by other researchers such as Esqueda-Esquivel *et al*. (2009) for *Cynodon plectostachyus* (58.2 up to 103 g/kg DM), Juárez *et al*. (2004) for *Brachiaria decumbens* with 78. 6 g/kg DM and Bernal *et al*. (2008) for *Paspalum notatum* with 73 g/kg DM. This indicated that the CP amount was different for each species, depending on the location of production, the management of the pasture and the climate (Reyes-Purata *et al*. 2009).

The amount of structural carbohydrates is a factor to be considered in determining the intake and digestibility of organic matter. Intake decreases as the plant matures, and lignification increases (Van Soest *et al.* 1991). Results indicated that the NDF obtained in this study was similar to that reported by Evitayani *et al*. (2005) for *Brachiaria decumbens* (639 g/kg DM) and *Cynodon plectostachyus* (603 and 672 g/kg DM). For *Paspalum notatum*, Avilés *et al*. (2008) reported 679 g/kg DM of NDF and 361 g/kgDM for ADF contents.

The plant's maturity and lignification also influence the dOM and ME content. Differences among periods (P≤0.05) were observed for both variables. Pérez *et al*. (2001) reported comparatively lower digestibility (46.45%) for *Cynodon plectostachyus*. In addition Moura *et al*. (2002) and Bernal *et al*. (2008) reported similar dOM for *Brachiaria decumbens* of 550 g/kg DM and 590 g/kg DM for *Paspalum notatum*, respectively. Energy in the form of non-fibrous carbohydrates is the first limitation for animal production, and it also limits the use of crude protein in

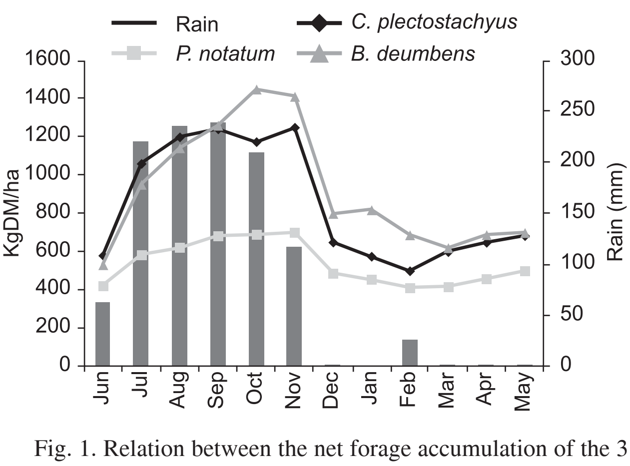

Fig. 1. Relation between the net forage accumulation of the 3 grass species, with respect to the precipitation in the southern region of the state of Mexico.

grasses (NRC 2001).

Precipitation is one of the climatic variables that had most influence on forage production (Fig. 1). Forage production increased with precipitation and diminished when the rains stopped. Researchers such as Juarez-Hernandez *et al.* (2007) and Lopez-González *et al.* (2010) reported that precipitation was an important factor in the amount of dead matter produced in pastures.

It was concluded that nutritional characteristics of the three grass species evaluated were very similar, but in terms of dry matter yields, greater production was observed in the introduced grasses than in the native grass. Precipitation is a factor that determines, to a large extent, the quantity and quality of grasses in the pastures.

REFERENCES

AFRC. 1993. *Energy and Protein Requirements for Ruminants*. An advisory manual prepared by the AFRC technical committee on response to nutrients. CAB International, Wallinford, UK, 159 p.

Ankom Technology. 2004. *In vitro* true digestibility using the DAISY II incubator. Consulted at http://www.ankom.com/09procedures/daiy in May 2009.

AOAC. 1990. Protein (crude) in animal feed. Copper catalyst kjeldahl method. *Official Method of Analysis of The Association of Official Analytical Chemists.* 15th edn, p. 74.Arlington, Virginia.

Avilés N F, Espinoza O A, Castelán O OA and Arriaga J C M. 2008. Sheep performance under intensive continuous grazing of native grasslands of *Paspalum notatum* and *Axonopus compresus* in region of the highlands of central México. *Tropical Animal Health and Production* **40**: 509–15.

Bargo F, Muller L D, Delahoy J E and Cassidy T W. 2002. Milk response to concentrate supplementation of high producing dairy cows grazing at two pasture allowances. *Journal of Dairy Science* **85**: 1777–92.

Bernal L, Ávila P, Ramírez G and Lascano C. 2008. Efecto de la suplementación con heno de *Calindra calothyrsus*y *Vigna unguiculata* sobre la producción de leche por vacas Holstein × cebú en Colombia. *Asociación latinoamericana de producción animal* **16**: 109–14.

Carta Estatal de Regionalización Fisiográfica. 1980. Estado de México. Escala 1:500 000. Coordinación de Servicios Nacionales de Estadística, Geogra2fía e Informática. Secretaría de Programación y Presupuesto. México.

Elizondo J and Boschini C. 2003. Valoración nutricional de dos variedades de maíz usadas en la producción de forraje para bovinos. *Pastos y Forrajes* **26**: 347–53.

Esqueda-Esquivel V A, Montero-Lagunes M and Juárez-Lagunes F I. 2009. Efecto de métodos de control de maleza en la productividad y calidad del pasto estrella de áfrica (*Cynodon plectostachyus* (K. Shum.) Pilg.).*Tropical and Subtropical Agroecosytems* **10**: 393–404.

Evitayani, Lili W, Armina F, Toshiyoshi I, Shaukat A, Maki H and Tsutomu F. 2005. Nutritive value of selected grasses in north Sumatra, Indonesia. *Journal of Animal Science* **76**: 461–68.

García E. 1988. Modificaciones al sistema de clasificación climática de Köppen (para adaptarlo a las condiciones de la República Mexicana). (Universidad Nacional Autónoma de México).4taedición, pp 1–50. México.

Hernández S R, Jaime O P, Régul J G and Elías H. 2005. Manejo de praderas asociadas de gramíneas y leguminosas para pastoreo en el trópico. *Revista electrónica REDVET*. http: www.Veterinaria.org/revista/redvet/n050505.html.

Hodgson J. 1994. Manejo de pastos. Teoría y práctica. (Diana). 1^{era} edición, pp. 55–180. México.

Juárez H J, Bolaños E D and Reinoso M. 2004. Content of protein per unit of dry matter accumulated in tropical pastures. *Cuban Journal of Agricultural Science* **38**: 415–22.

Juarez-Hernández J and Bolaños-Aguilar E D. 2007.Las curvas de dilución de la proteína como alternativa para la evaluación de pastos tropicales. *Universidad y Ciencia* **23**: 81–90.

López-González F, Estrada-Flores J G, Avilés-Nova F, Yong-Angel G, Hernández-Morales P, Martínez-Loperena R, Pedraza-Beltrán P E and Castelán-Ortega O A. 2010. Agronomic evaluation and chemical composition of african star grass (*Cynodonplectostachyus*) in the southern region of the state of México.*Tropical and Subtropical Agroecosy tems* **12**: 1–9.

Macedo R, Galina M A and Zorrilla J M. 2008. Balance energético y proteico de un sistema de producción tradicional de doble propósito en México. *Zootecnia Tropical* **26**: 455–63.

Minitab 2003. V 14 Statistical software. User's guide II: Data analysis and quality tools, graphics, and Macros. USA.

Moura L O, Braga C M, Bastos de Veiga J and Amador N. 2002. Avaliação de pastagem de quicuio-da-amazônia (*Brachiaria humidicola* (Rendle) Schweickerdt) en sistema de pastejorotacionado intensivo, in Belén, Pará. *Pasturas Tropicales* **24**: 30–9.

NRC. 2001. *Nutrient Requirements of Dairy Cattle*. (National Academy Press).7th rev.edn, 381 pp Washington, D. C..

Pérez P J, Alarcón Z B, Mendoza M G, Bárcena G R, Hernández G A and Herrera H J. 2001**.** Efecto de un banco de proteína kudzu en la ganancia de peso de toretes en pastoreo de estrella africana. *Técnica Pecuaria México* **39**: 9–52.

Pinzón R and Montenegro R. 2001.Prácticas de manejo y utilización de asociaciones de gramíneas/leguminosa (*Arachis pintoi*) y gramíneas solas. Instituto de Investigaciones Agropecuarias de Panamá p. 5–44.

Reyes-Purata A, Bolaños-Aguilar E D, Hernández-Sánchez D, Aranda-Ibañez E M and Izquierdo-Reyes F. 2009. Producción de materia seca y concentración de proteína en 21 genotipos del pasto humidícola *Brachiaria humidícola* (Rendle) Schweick. *Universidad y Ciencia* **2**: 213–24.

Rincón C A, Ligarreto M G A and Garay G. 2008. Producción de forraje en los pastos *Brachiaria decumbens*cv Amargo y *Brachiaria brizanta*cv Toledo sometidos a tres frecuencias y a dos intensidades de defoliación en condiciones del piedemonte llanero colombiano. *Revista Facultad Nacional de Agronomía-Medellín* **61**: 4336–46.

Steel R G D and Torrie H. 1997. Bioestadística: Principios y procedimientos, (McGraw-Hill) 2daedición, 539 p. México.

Van Soest P J, Robertson J B and Lewis B A.1991. Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* **74**: 3583–97.