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REVIEW [REVISIÓN]

AGRONOMIC AND FORAGE CHARACTERISTICS OF *Guazuma ulmifolia* Lam.

[CARACTERÍSTICAS AGRONÓMICAS Y FORRAJERAS DE *Guazuma ulmifolia* Lam.]

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SUMMARY

Native trees are an important source of forage for livestock, particularly in regions having prolonged dry periods. Some tree species have fast growth rates, good nutritional quality, and the ability to produce forage during dry periods when the need for forage is greater. *Guazuma ulmifolia* Lam. is a tree native to tropical America that has a high forage potential. This species is mentioned in a number of studies assessing the forage potential of trees in a diverse array of environments and vegetation communities, but little is known about its agronomic management, but there is a lack of published information on adequate management and cultivation of this species as a forage tree. There is enough information on the nutritional value of the species, but supplementation with this forage and resulting animal responses have not been extensively studied. Therefore, the objective of this study was to assess the available literature for information on the presence, management, and forage quality of *G. ulmifolia* in production systems with domestic ruminants.

Key words: Protein bank; *Guazuma ulmifolia*; seed scarification; silvopastoral systems.

RESUMEN

Los árboles nativos son una fuente importante de forraje para el ganado, sobre todo en regiones con época de estiaje prolongada. Algunas especies arbóreas son de rápido crecimiento y buena calidad nutricional, además de tener la capacidad de producir forraje durante la época seca, cuando la necesidad de forraje es mayor. El guácimo (*Guazuma ulmifolia* Lam.) es un árbol nativo de América tropical que tiene un alto potencial forrajero y del que aún se conoce poco sobre su manejo agronómico. El guácimo es una especie que aparece en muchos estudios de diagnóstico de especies forrajeras en diversos sitios y asociaciones de vegetación, pero existe escasa información publicada sobre su manejo agronómico adecuado para ser cultivado como árbol forrajero. Existe información sobre el valor nutricional del guácimo, aunque la suplementación y la respuesta animal con esta especie tampoco han sido estudiadas de manera extensa. Por lo tanto, el objetivo de este estudio fue analizar la literatura existente sobre la presencia, el manejo y la calidad forrajera del guácimo en sistemas productivos con rumiantes domésticos.

Palabras clave: Banco de proteína; escarificación de semillas; sistemas silvopastoriles.

INTRODUCTION

Guacimo is a tree native to tropical Latin America with good forage qualities, and is found from Mexico to the southern Brazil, and in the Caribbean. This tree belongs to the family Sterculiaceae, genus *Guazuma* and species *ulmifolia* Lam. (CATIE, 2006). The common names are varied and include guacimo, guazamo, caulote, pixoy, guacimo de ternero, majagua de toro, yaco and granadillo. The tree is characteristic of zones with well defined dry seasons and savanna vegetation, and pastures in hot-humid areas (Nieto *et al.*, 2006; Lopez *et al.*, 2006), although it also grows in more humid ecosystems, in open spaces, along edges of highways and rivers, in cultivated areas, pasturelands and secondary vegetation (Lopez *et al.*,

2006; Ascencio, 2008). In the central part of the state of Veracruz, Mexico, this species has evolved in regions where precipitation is seasonal and very marked, with dry periods lasting up to eight months (Lopez *et al.*, 2006).

Guacimo is considered a multipurpose tree because of the great variety of products and services it provides to agriculture, ranching, the cosmetics industry and medicine. Berenguer *et al.* (2007) mention its antihypertensive, antimicrobial, and antioxidant properties; Alonso-Castro and Salazar-Olivo (2008) highlight its use in countering diabetes; its use in cosmetics, candies, beverages, omelets, atole and pinole are reviewed in EMB (2007); in agroforestry the tree serves as a living fence and shade for resting cattle (Torres *et al.*, 2006); the foliage is a source of protein in livestock grazing systems (Lopez *et al.*, 2006; Villa *et al.*, 2009); and it provides structure and protection for flora, fauna and sources of water for soil enrichment (Beetz, 2001; Jimenez and Hernandez, 2001), thus helping to conserve natural resources. Its soft wood is used in the manufacture of artisanal crafts, equipment for picking fruits, house construction, furniture, posts, livestock facilities, and is a source of firewood and coal (Giraldo *et al.*, 1995; Nieto *et al.*, 2006). As such, *G. ulmifolia* is also considered to be an important forage species in tropical regions with low precipitation and soil productivity (Giraldo *et al.*, 1995; Lopez *et al.*, 2003). The objective of this review is to present information on the agronomic and forage characteristics of guacimo.

Desirable characteristics of forage trees

Potential forage trees should possess certain characteristics that allow them to adapt to their environmental conditions and to prolong their productive life (Benavides, 1998; Febles and Ruiz, 2008) which are grouped as follows:

1) Agronomic characteristics

a) Rapid growth
b) Adaptation to soils having low fertility
c) Resistance to fires, illnesses and plant pests
d) Abundant foliage production by rapid mineralization
e) High biomass production during dry seasons
f) High seed production and easy propagation
g) High survival capacity when stablished in the field

2) Capacity to associate to other plant

a) Possitively interact with other trees and grasses
b) Posses a deep root system
c) Permits the growth of other plants under its canopy

3) Defoliation response

a) Adequate response to pruning and frequent trimming and browsing
b) High production of buds after defoliation

4) Nutritional value and consumption

a) High passage rate through the digestive tract
b) High nutritional value
c) High edonic value for domestic ruminants
d) Low content of secondary metabolites that will not affect voluntary consumption
e) Improve performance of livestock

General botanic and biological aspects of guacimo

Guacimo is a tree of medium size, although the height of some trees has been reported to be 25 m, canopy (EMB, 2007). It is a much ramified tree, with a rounded, open and extended. Its leaves are alternate and simple, from 3 to 13 cm long and 1.5 to 6.5 cm wide, with an oval or lanceolate form, serrate margin, dark green color and rough and scabrous texture on the dorsal. Its flowers are distributed in panicles from 2 to 5 cm long, having the form of a star with a white-yellowish, or brown color and sweet smell, and a diameter of 5 mm. The trunk diameter can reach 80 cm (EMB, 2007), is nearly straight, ramified near the base with long branches extended horizontally and at times hanging. The tree has fissured external bark that is grayish-brown in color, while the internal bark is fibrous, yellow to brown-red, with a sweet to astringent flavor (Francis, 1991). The fruits have the form of a capsule from 3 to 4 cm long, with numerous conical protuberances on the surface and are dark coffee to black in color; when mature they have a sweet smell and flavor (EMB, 2007). The seeds are hard in consistency, with lentil-like form, a size less than 1 mm, and are brown in color, although this can vary. The number of seeds per fruit varies from 40 to 80 and the quantity is not related to fruit length or diameter (Leyva, 2003).

In Costa Rica, the tree flowers from March to April (Giraldo, 1998), in Puerto Rico from April to October (Francis, 1991), and in Mexico from May to September (Nieto *et al.*, 2006). Fruit maturation in guacimo varies according to the climatic characteristics of the location in the dry tropics of Mexico It occurs primarily during the dry season (Contreras *et al.*, 1995; Palma and Roman, 2003; Manriquez *et al.*, 2007), but can occur almost all year (from September to April), while in Nicaragua fruiting occurs from February to May during the dry season

(Zamora *et al.*, 2001). In mixed forest areas of Brazil, the fruits mature during August and September and remain on the tree until November (De Araujo *et al.*, 1999), while in Mexico this process occurs from March to December.

On the other hand, guacimo is a deciduous tree; its leaves begin to age during the dry season for periods of different duration. In some climates the periods are short (EMB, 2007) or long, but the time will depend chiefly of the duration of the dry season. This natural leaf drop helps to avoid the loss of humidity by sweating (Ortega, 2009).

Propagation of guacimo

Guacimo propagates sexually (seeds) and asexually (vegetative). Sexual reproduction in this species is the most common, and this has been found to be the best form for artificial propagation (Villarruel *et al.*, 2007).

Natural dispersal of guacimo seeds is by means of consumption of the mature fruit by birds and mammals (primarily bats and cattle) (Ferguson *et al.*, 2007). This form of dispersal allows the seeds to germinate easily. For controlled propagation of guacimo, the first step is the harvesting of mature fruits (Figure 1) directly from the tree or the soil, however in this last case the fruits should not be infested with larvae (Manriquez *et al.*, 2007). The fruits are then split open and the seeds are extracted with smooth forceps or probes, or with aid of blunt scissors. The seeds are then cleaned to remove all fruit residue. Seed harvesting varies according to the region, because climatic conditions affect fruit ripening (Giraldo, 1995; Ku *et al.*, 1998; Calderon and Lara, 2007).

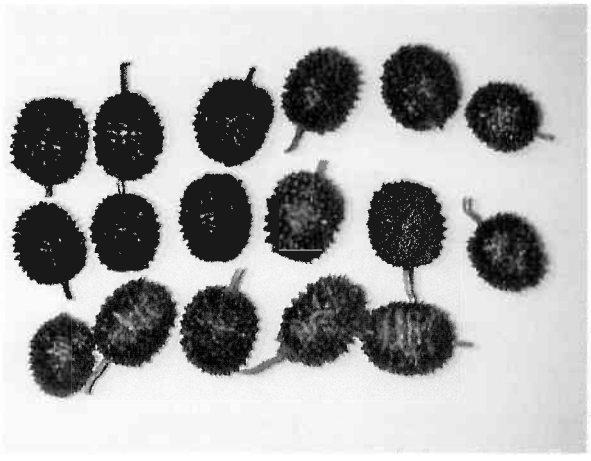

Figure 1. Mature fruits of *Guazuma ulmifolia* Lam.

Under natural conditions in the absence of predators, the rate of seed germination is low (Villarruel *et al.*, 2007; Hermosillo *et al.*, 2008), since they require the process of scarification to achieve a high percentage of germination. To scarify the seeds, Sanchez *et al.* (2004) suggest the seeds be submerged in water at 100 °C for 10 sec and then soaked in water at room temperature for 24 hours. However, Villarruel *et al.* (2007) recommend soaking the seeds in water at 80 °C for 8 to 10 min, and then leaving them in water at room temperature for 24 to 36 hours to assure 95 % germination, although 5 min in water at 80 °C is sufficient (Manriquez *et al.*, 2007). After this processing, the seeds are washed in a fine-meshed screen with running water until the mucilage is removed, and left to dry in the shade (Figure 2).

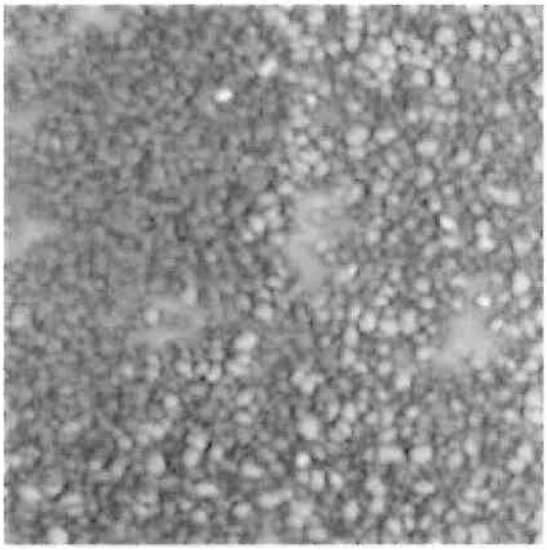

Figure 2. Scarified seeds of *Guazuma umifolia* Lam.

The seeds germinate from 4 to 8 days after sowing, and they can germinate in bags or seedbeds; in both cases they need shade during germination. If they sprout in a seedbed, then when the seedling produces two true leaves (approximately eight days after sprouting), they can be transferred to polyethylene bags filled with soil (Lopez *et al.*, 2006; Manriquez *et al.*, 2007). Seedlings should be provided with an 50 % shade, with daily irrigation for eight days, and subsequently every other day, so as to stimulate ligneous growth in stems and branches. They can be fertilized with N-P-K in the proportion 10-30-10, using 3 to 4 g per plant (Villarruel and Ruiz, 2004).

No data on the management of guacimo exists for nurseries; only Tamayo and Orellana (2006) in the Yucatan, and Manriquez *et al.* (2007) in central Veracruz state report that if germination in nurseries is carried out in May, one to two months before the rainy season begins.

As for asexual propagation, Villarruel *et al.* (2007) obtained 35 % survival when reproducing guacimo by means of air layering (Figure 3), while 42 % survival

was achieved using plant cuttings 20 cm long and 1 cm wide, and using a substrate containing 65 % soil and 37.5 % compost and other materials.

Figure 3. *Guazuma ulmifolia* Lam. propaged by means of air layering.

Considerations for the establishment of guacimo in the field

To establish a guacimo plantation, whether in a nursery or in the field, the climate, rainy season, soil type and slope must be considered (Tamayo and Orellana, 2006). Few reports exist in the literature referring to the conditions and requirements for transplanting guacimo to the field. According to Villarruel *et al.* (2005), guacimo can be transplanted during three or four months of age, when the plant has reached a height of 38 cm. Manriquez *et al.* (2007) also indicate that transplantation may be performed when the plants are between 1 and 2 months of age, and 20 to 30 cm in height. CATIE (1991) mentions that the plants should be protected from the air and sun during transportation. Planting of young trees should be carried out during the rainy season, preferably at the beginning, so that they have the opportunity to develop over the entire period of rains (Manriquez *et al.*, 2007). Tamayo and Orellana (2006) reported 100 % survival of guacimo when established in places receiving 1,200 mm of precipitation in the Yucatan, Mexico.

The spatial arrangement of guacimo trees in the field depends on the purpose and type of system desired. Trees have been planted using simple or double hedge rows designs (Tamayo and Orellana, 2006; Villa, 2009), or well under a design in staggered formation, in such a way that the plants form equilateral triangles (Villarruel *et al.*, 2007). Planting space between trees in fodder banks is commonly 1 to 1.5 m with row spaces of 1.5 m (Lopez *et al.*, 2006; Figure 4), or in 4 m wide alleys for silvopastoral systems (Villa, 2009; Manriquez, 2010); Tamayo and Orellana (2006) have cultivated this species with 1.25 m of space among plants.

Figure 4. Hedges of *Guazuma ulmifolia* Lam. and *Digitaria decumbens* Stent.

Management of guacimo in production systems

The age of the trees at the moment of their first pruning is very important because this practice determines the subsequent growth and development of the stems and roots, impacting the tree performance (Francisco, 2003). Although the best age to practice the first pruning for this species is not known, Holguín and Ibrahim (2004) mention that at the age of six months after its establishment in the field, consumption by animals can begin while Lopez *et al.* (2006) have performed a first prone to trees 6 months old. Lopez *et al.*, 2006) suggest a traditional pruning of a guacimo forage bank to leave main stems at 60 cm of height, and main branches and secondary branches at 40 cm of length from the base of the stem. Francisco (2003) suggests that an acceptable time to define intervals of pruning in trees exists when the plants possess between 50 and 60 % edible foliage. According to Leyva (2006), guacimo has shown favorable response and resistance to cattle grazing pressure. In this respect, Lopez *et al.* (2006) indicate that at 6.3 months of establishment in the field, sheep can initiate grazing without damaging or compromising plant survival. Nevertheless, Villa (2009) reported that when cattle grazing was practiced in a silvopastoral system with trees at one year of age, the development of the trees was delayed, although their survival was unaffected.

On the other hand, plant age is important for biomass production; greater vegetative growth provides greater production of biomass. Plant height also positively influences the quantity of biomass produced (Giraldo *et al.*, 1995). Guacimo biomass production has been evaluated mostly for trees growing naturally in different places, and not for trees growing in plantations at high densities and/or under more controlled conditions. Table 1 presents the diverse systems of guacimo management and their biomass production.

In general, the production of biomass and fiber increases over long periods of pruning or grazing, and the percentage of crude protein declines. However, over smaller intervals of time, biomass and fiber are reduced and the amount of raw protein increases (Lizarraga *et al.*, 2001). In Tabasco, Mexico, Reyes (2006) with four month pruning intervals during the year; obtained 1.5 kg DM tree^{-1} with 41.9 % edible foliage. In turn Lopez *et al.* (2006) obtained 2.6 t DM ha^{-1} from a forage bank at the first pruning, while Villa (2009) achieved 1.7 t DM ha^{-1} in a 7 month period in a silvopastoral system with 4,000 one year old trees ha^{-1}.

Forage quality of guacimo

Various investigators (CATIE, 1991; Lizarraga *et al.*, 2001; Zamora *et al.*, 2001; Palma and Roman, 2003) have evaluated the nutritional quality of guacimo foliage and fruits with variable results. The quality depends on the soil and climatic conditions of the location, time of year, age of regrowth, plant management and animal consumption (Lopez *et al.*, 2008). Crude protein (CP) content in guacimo fruit an forage varies; the minimum reported in fruits was 5.8 % in the humid tropics of Chiapas, Mexico, (Pinto *et al.*, 2004), and the maximum was 11.3 % in ground dry fruit from the tropical dry climate of Colima, Mexico (Contreras *et al.*, 1995). In Costa Rica, Giraldo (1998) reported CP of 5.5 % in foliage from trees at medium density (2,795 trees ha^{-1}) in winter, while Araya *et al.* (1994) obtained 23 % CP in a pre-montane forest. In tropical sub-humid Veracruz, Mexico, during the rainy season, in poor soil conditions, Villa (2009) also reported 23 % CP. There is greater CP in leaves than in stems, ranging from 16 % (CATIE, 1991) to 19.5 % in leaves (Araya *et al.*, 1994), and from 5.2 % (Lizarraga *et al.*, 2001) to 8.1 % in stems (Araya *et al.*, 1994).

The degradability of edible guacimo biomass depends on the age of regrowth and the position of the branches. In fruits, DDM ranges between 49 % and 66 % for ground mature fruit, with a greater digestibility if NaOH is added to the ground fruit (Contreras *et al.*, 1995). In foliage, the dry matter digetibility values range from 41 % (Pinto *et al.*, 2004) to 94 % (Giraldo, 1998). Other authors have reported intermediate values of digestibility (47.2 %) in the Yucatan (Bobadilla and Ramirez, 2006), and high values (60 %) with 4 month regrowth in Tabasco, Mexico (Reyes, 2006).

Ash content permits an evaluation of the organic matter in forage, and it varies little. In fruit, CATIE (1991) reported values of 5.5 %, while Contreras *et al.* (1995) reported 11 %, the maximum value reported for mature fruits. Ash content in foliage ranges from 8.6 % in Costa Rica (CATIE, 1991) to 14 % in four year old guacimo plants and 70 days of regrowth during the rainy season in Veracruz, Mexico (Lopez, 2008).

Table 1. Average guacimo biomass production in different management systems.

Production System	Density and/or arrangement	Management	Biomass	Reference
Dispersed in forest	n.a.	Trim at /16 Weeks intervals	1.7 kg DM tree^{-1}	Flores, 1994
Induced SS	20 trees ha^{-1}	Adult trees	1.2 t DM ha^{-1}	Giraldo, 1998
Dispersed trees	n.a.	A single trim of 8 m high trees	29 kg DM tree^{-1}	Lizarraga *et al.*, 2001
Forage bank	8,100 trees ha^{-1}	Trim at/8 Weeks intervals	2.6 t DM ha^{-1} in 6.5-months	Lopez *et al.*, 2006
Native assemblage	n.a.	Fruit recolection	17.5 kg tree^{-1}	Palma and Roman, 2003
Dispersed trees	1.5 m high trees	Trim at/16 Weeks intervals	1.5 kg DM tree^{-1} in one year	Reyes, 2006
Intensiv SSP	4,000 trees ha^{-1}	Trim at/ 5 Weeks intervals	1.7 t DM ha^{-1} in 7 months.	Villa, 2009

SSP=Silvopastoral system, DM=dry matter

The range for neutral detergent fiber (NDF) of fruits and foliage also has been reported to be wide. The lowest value for fruits is 46.1 % reported by Pinto *et al.* (2004) in Chiapas and the highest is 60 % reported in Colima (Palma and Roman, 2003), both in Mexico. In foliage, 41.1 % of NDF has been found in trees used by cows in the Yucatan (Bobadilla *et al.*, 2006), and 74 % in forage of 70 days old regrowth for supplemented to sheep in Veracruz, Mexico (Lopez, 2008). Acid detergent fiber (ADF) for fruits ranges from 29.4 % to 46 % in feeds containing urea and NaOH (Contreras *et al.*, 1995), while a range from 26 % (Lizarraga *et al.*, 2001) to 57 % (Villa, 2009) for one year old plants during the rainy season in Veracruz, Mexico.

The lowest value of reported fruit cellulose is 19.2 % (Contreras *et al.*, 1995), and the highest is 30 % (Palma and Roman, 2003), both reported from Mexico. Araya *et al.* (1994) reported cellulose content of guacimo foliage to be 19 % in tropical premontane forest in Costa Rica, while Lopez (2008) reported 35 % in Veracruz, Mexico. Palma and Roman (2003) found fruit hemicellulose to be 6.1 %, and Contreras *et al.* (1995) reported 14.0 %, both from Colima, Mexico. Values of 8 % in Brazil (De Araujo, 1999) and 31 % in Veracruz, Mexico (Lopez, 2008) also have been reported.

Information on the lignin content in fruits and foliage is scarce. Contreras *et al.* (1995) reported 9.0 % to 26.8 % in fruits from Colima, Mexico, while in the foliage a concentration of 3.4 % was indicated from Veracruz, Mexico (Lopez, 2008).

Guacimo forage is known to contain tannins. Lopez *et al.* (2004) analyzed the tannin content of guacimo DM from 20 tree species in the Mexican tropics, and found free (129.7 g kg^{-1} DM), and total condensed tannins (205.9 g kg^{-1} DM) in the forage. However, the content of this metabolite as many others varies with forage age, location and time of year (Scull, 2004). Cardenas *et al.* (2003) found 1.2 g kg^{-1} tannins in the foliage of guacimo from areas receiving 1,000 mm of precipitation, Lizarraga *et al.* (2001) reported 3.5 g kg^{-1} of DM, and Bobadilla and Ramirez (2006) reported 6.3 g kg^{-1} from the Yucatan, Mexico. The content of these metabolites is important because it is negatively related to digestibility and can affect the consumption and nutrient value of the forage (Soca, 2004). Yet, little information exists on the content of tannins in guacimo and their effect on animal consumption and productivity.

Consumption

Foliage consumption by cattle as well as forage quality is reflected in the changes in the reproductive and productive parameters of the animals. Ku *et al.* (1998) as well as Lopez *et al.* (2008) indicate that supplementing ruminant diets with forage trees stimulates food consumption. Upon offering several species of trees to goats for consumption, Vallejo *et al.* (1994) observed that consumption was increased, and that the goats had a greater preference for guacimo foliage compared to other preferred trees.

Evaluations of the consumption of foliage and fruits of guacimo have been reported in sheep. Supplementation with fruits stimulates the voluntary consumption of DM, increases the bacterial population of the rumen and reduces the population of ciliate protozoa (Navas *et al.*, 1999). In the Yucatan, Cardenas *et al.* (2003) preserved guacimo foliage in a microsilo, and demonstrated that it had good organoleptic characteristics and chemistry for animal consumption, with 8.4 % CP. In turn, Palma and Roman (2003) supplemented with fruit meal from five species including guacimo, obtained greater consumption of guacimo, with 160.8 ± 5.1 g DM $animal^{-1}$, obtaining 94 % of acceptance by hair lambs.

Some studies have indicated that guacimo is a forage preferred by sheep (Sosa *et al.*, 2004). Lopez (2008) offered chopped forage ad libitum to sheep and observed greater consumption when guacimo was offered alone (107.9 g $kg^{-0.75}$) compared to only grass, achieving a weight gain of 50 g $animal^{-1}$ day^{-1}. Medina (1994) evaluated the consumption of several forage trees along with supplementation of guacimo for young grazing goats and obtained a consumption of 608 g $animal^{-1}$ day^{-1} and a weight gain of 71 g $animal^{-1}$ day^{-1}.

With regard to the consumption of guacimo by cattle, Perez *et al.* (2006) evaluated the consumption and weight gain of cattle that received a combination of guacimo and pasture grass (*Panicum maximum* var Tanzania), and those that only were fed with grass (*P. maximum* var Tanzania). They obtained greater weight gain from systems having guacimo and pasture grass (*P. maximum* var Tanzania) (486 g $animal^{-1}$ day^{-1}) in comparison with pasture grass monocultures (369 g $animal^{-1}$ day^{-1}). Including guacimo as a supplement to the diet of cattle influences their consumption of DM and performance (Bobadilla *et al.*, 2006). In Nicaragua, one of the three native forage tree species that is most abundant is guacimo, where the foliage and fruits are used as supplements for cattle during the dry season (November to April). Zamora *et al.* (2001) reported consumption of guacimo foliage of 3.6 kg cow^{-1} day^{-1}, and from 0.9 to 2.3 kg $animal^{-1}$ day^{-1} of fruits for calves and lactating cows.

Presence of *Guazuma ulmifolia* in production systems

Many studies have reported the presence of *G. ulmifolia* in a variety of locations and production systems. CATIE (1991) indicated the presence of this species in natural associations of secondary forests in Central America, and it has been found in thorn cloud and tropical forests (EMB, 2007). In Veracruz, Mexico, Villegas *et al.* (2003) found it between 5 to 50 masl in low subcaducifolious forest, and between 10 and 900 masl in deciduous forest. Flores *et al.* (1998) found *G. ulmifolia* in humid premontane forest in Costa Rica. In Mexico, Francis (1991) reported the presence of guacimo in the initial succession stages of disturbed forests, and associated with species such as *Acrocomia mexicana* and *Hiliocarpus* spp. Grande *et al.* (2006) found guacimo in rain forest. Giraldo *et al.* (1995) reported the presence of this species in Colombia in tropical dry forest in the process of regeneration, and Zamora *et al.* (2001) reported its presence in the dry forests of Nicaragua. Some studies discuss the management of this tree in pasturelands (Francis, 1991; Pinto *et al.*, 2004; Torres *et al.*, 2006; Villa *et al.*, 2009), while others have been carried out in established plantations. In Mexico, this species has been evaluated in forage banks and established silvopastoral systems (Lopez *et al.*, 2006), in agrosilvopastoral systems in coastal plains, ridges, mountains and high plateaus of Veracruz (Torres *et al.*, 2006), and in established silvopastoral systems with intensive grazing in Chiapas, Mexico (Perez *et al.*, 2006). In Cuba, guacimo is predominantly found in association with natural vegetation in silvopastoral systems having low levels of management (Acosta *et al.*, 2003). In Veracruz, Bautista (2009) reported the existence of guacimo as a result of natural succession in pastures and agricultural fields.

Products and services from *Guazuma ulmifolia* Lam.

Guacimo is characterized as a multiple use species that provides a variety of products and services in diverse production systems in tropical regions (CATIE, 1991). It has productive capacity and quality forage in livestock systems (Giraldo, 1998; Lopez *et al.*, 2006), and its fruits are an alternate source of food for cattle during the dry season (Palma and Roman, 2003; Sosa *et al.*, 2004). As a forest resource, it serves as a living fence, a source of shadow and rest for cattle, and as wind breakers (Lopez *et al.*, 2006; Torres *et al.*, 2006). As a medicine, fruits have been reported to aid in contend diabetes (Martinez, 2006; Alonso-Castro and Salazar-Olivo, 2008), but it also has antihypertensive, antimicrobial and antioxidant properties, a not documented property is as a hem coagulant used in central Mexico. Moreover, this species has also been used to elaborate cosmetics, candies, beverages, omelets, hot drinks and pinole (a traditional Mexican beverage) (EMB, 2007). Its soft wood is used in the manufacture of artisanal crafts, equipment for picking fruits, broomsticks for house construction, furniture, fense posts, livestock facilities, and is a source of firewood and coal (Giraldo *et al.*, 1995; Nieto *et al.*, 2006; Bautista *et al.*, 2011 in press). Trees in landscapes provide conditions for bird nesting and wildlife protection. A great variety of plant species grow and under their canopy and falling leaves provide organic material and microorganisms to increase the availability of humidity and the use of water, light and nutrients, to fortify the ground cover and enrich the soils (Beetz, 2001; Jimenez and Hernandez, 2001; EMB, 2007).

CONCLUSIONS

G. ulmifolia Lam. is a species that possesses desirable characteristics as a forage tree. Its crude protein content, rusticity, resistance, persistence and palatability make it an important alternative source of protein for ruminant diets, especially in tropical regions during the dry season, when the availability of forage for cattle is significantly reduced. It is a species has the potential to improve livestock performance when they are provided with other forage species of low nutritious quality. Besides contributing to livestock diets, the presence of guacimo in pastures increases biodiversity, favors water conservation and soil fertility. Further research is necessary on the performance of sheep and cattle supplemented with guacimo to further understand its potential a source of forage in tropical silvopastoral systems.

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