

Effect of *Guazuma* Leaves (*Guazuma ulmifolia*) Inclusion as Protein Source on Growing Calves

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Abstract: The present work was undertaken in a cattle ranch of the north of Puebla state, Mexico. The aim was to incorporate *Guazuma* leaves (*Guazuma ulmifolia*) in the diet of growing calves and evaluate its effect on weight gain. Twenty-four Cebu × Swiss calves (approximately live weight 250 kg) were used during all the experimental period (64 d). They were assigned to a completely randomized design under two treatments ($n = 12$ for each treatment): control (T_1) consisted of commercial feed based on 15% crude protein (CP) + cut Taiwan grass and the treatment (T_2) consisted of a formulated diet containing 14.7% CP including *Guazuma*. The composition of the formulated diet consisted of: *Guazuma* (60%), rolled corn (12%), ground sorghum (9%), oats in grain (7%), wheat bran (9%) and vitamins and minerals. The feed was offered twice a day at a rate of 3% of live weight for 64 d. The mean daily gain for T_1 and T_2 was 1.15 g/animal and 1.52 g/animal, respectively ($p < 0.05$). Results indicate that *Guazuma*-based supplements resulted in greater productive yield in growing calves.

Key words: Calves, *Guazuma*, supplementation, weight gain.

1. Introduction

In most of the tropical and subtropical zones, native grasses are the basic diet for bovine. They are characterized by their low nutritive value; another limitation of grasses is their marked seasonality in terms of fodder production: being abundant during the rainy season and deficient in the dry season. Thus, an urgent need of concentrate incorporation will be justified. This will cause an increase of production costs and make livestock unprofitable [1].

Contrastingly, trees and shrubs have been used for thousands of years for a variety of purposes. Clavero et al. [2] mentioned that direct use, particularly of legumes, to produce fodder is mainly advantageous because of the high protein content of foliage and fruits. Also, the use of tree species in animal feed provides a favorable ambiance in the rumen that induces better fermentation and digestion of low quality fodder [3].

Mexico has a large number of important native trees that provide forage for animal feed (Table 1), providing an option for overcoming problems of scarcity and low quality pasture. These trees are of good nutritional quality and, unlike pasture, they continue to produce in periods of seasonal drought [4]. Most of the tree species studied manifest a higher crude protein (CP) content than that of tropical grasses, and in several cases also that of commercial concentrates [5].

Guazuma (*Guazuma ulmifolia*) is a tree that belongs to the Sterculiaceae family, which is distributed throughout continental America [6]. It typically grows on open sites, river banks and in forests. It grows rapidly, adapting to both arid and humid areas, presenting a height of approximately 20 m. It has a round and extended crown, with a twisted and branched trunk [7]. It is an important tree in silvopastoral systems, as forage and fruits are highly nutritious and appetizing to cattle, leaves have a protein content of 13%-17% and fruits of 7%-10% (Table 2) and are consumed by cattle, horses, sheep,

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Table 1 CP and crude fiber content of arboreal species [5].

Species	DM (%)	CP (%)	CF (%)
<i>Guazuma ulmifolia</i>	37.6	18.6	54.3
<i>Cnidoscolus aconitifolius</i>	16.5	42.4	86.6
<i>Morus</i> spp.	28.7	23.0	79.9
<i>Crescentia alata</i> (flowers)	17.6	11.0	77.6
<i>Cnidoscolus chayamansa</i>	9.3	30.8	74.8
<i>Verbesina myriocephala</i>	19.8	23.0	71.5
<i>Senecio salignus</i>	26.5	23.4	71.5
<i>Ficus</i> spp.	16.9	14.4	71.3
<i>Verbesina turbacensis</i>	20.6	20.8	70.8
<i>Hibiscus rosa-sinensis</i>	24.8	21.0	70.0
<i>Lonchocarpus guatemalensis</i>	12.4	19.5	69.4
<i>Brosimum alicastrum</i>	18.9	12.7	67.2
<i>Roupala complicata</i>	26.6	42.5	66.9
<i>Malvaviscus arboreus</i>	16.5	22.4	64.5
<i>Hamelia patens</i>	15.6	17.5	61.6
<i>Mimosa platycarpa</i>	17.8	16.0	60.0
<i>Gliricidia sepium</i>	25.1	21.6	59.2
<i>Libidibia coriaria</i>	19.0	16.0	59.0
<i>Trophis racemosa</i>	20.1	12.9	56.5
<i>Erythrina berteroana</i>	22.9	24.3	55.0
<i>Dendropanax arboreus</i>	22.0	12.1	52.7
<i>Cecropia peltata</i>	19.7	19.8	51.8
<i>Erythrina poeppigiana</i>	24.0	23.8	51.3
<i>Erythrina cocleata</i>	24.3	21.6	51.2
<i>Stemmadenia donnel-smithii</i>	19.1	24.4	50.6
<i>Polimnia</i> spp.	17.9	22.1	45.2
<i>Cordia dentata</i>	41.0	16.0	36.0

DM: dry matter; CP: crude protein; CF: crude fiber.

Table 2 Nutritive values of mature leaves and mature fruits of *G. ulmifolia* [8-10].

	DM (%)	CP (%)	CF (%)	EE (%)	CA (%)	NFE (%)	NDF (%)	ADF (%)	ADL (%)
Mature leaves	95.1	16.1	28.1	1.3	8.6	45.9	46.1	40.0	16.5
Mature fruits	92.5	6.8	40.3	2.1	5.5	45.4	68.7	55.4	18.7

DM: dry matter; CP: crude protein; CF: crude fiber; EE: ether extract; CA: crude ash; NFE: nitrogen free extract; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin.

goats and pigs [11].

In Mexico, although it is important in providing milk and meat for human consumption and the conservation of natural resources and the environment, cattle farming is facing a great challenge for increasing its productivity. The main desirable characteristics of trees with multiple uses are found in one or more fodder trees, which have the capacity to sustain repeated pruning and good capacity for regrowth [6]. Therefore, in this research, it is proposed

the evaluation of the effect of incorporating *G. ulmifolia* leaf in the diet of growing calves.

2. Materials and Methods

This research was developed in the northern area of Puebla state, Mexico, in the municipality of Pantepec, geographically located at latitude 21°16' N, longitude 98°22' W of the meridian, at a height of 160 masl, during the period from September to November 2016.

Twenty four cross breed (Cebu × Swiss) calves

(live weight \pm weighing approximately 250 kg) were allocated to two treatments under a completely randomized design ($n = 12$). Control treatment (T_1) was commercial food with 15% CP. Test treatment (T_2) consisted of a diet formulated from *Guazuma* leaves (*G. ulmifolia*) with 14.7% CP (Table 3).

The commercial food for T_1 consisted of: 28% ground corn, 28% ground sorghum, 15% molasses, 13% soybean meal, 8% green alfalfa, 5% barley, 3% minerals, vitamin A, D3 and E with 15% CP and 70.02% total digestible nutrients (TND).

An area of 2 ha of *Guazuma* was identified, it was observed that the trees were sufficient to have an adequate amount of foliage available for the rations; a sample of 400 g was taken and analyzed in the bromatology laboratory of the Tuxpan campus, Faculty of Biological and Agricultural Sciences, Veracruz University to determine the nutritional contribution, following the method proposed by Van Soest [12] (Table 3). T_2 rations were made using this information. The period of adaptation to the use of the *Guazuma* foliage was 10 d in grazing under voluntary consumption.

Guazuma leaves were collected manually for the elaboration of T_2 . Food was produced using a chopper (Kohler, 6.5 hp, 196cc), completely shredding the *Guazuma* leaf. The 60 kg of chopped fresh *Guazuma* leaves were placed on an extended canvas while

adding the other ingredients (Table 4), and mixing carefully until homogenous food was obtained. Other ingredients were added in order to have a balanced nutrient supply based on the daily requirements for growing calves proposed by the National Research Council (10%-18% CP) [13]: rolled corn, ground sorghum, grain oats, wheat bran; vitamins A, D3 and E; minerals: sodium, zinc, manganese, copper, magnesium, selenium, cobalt, iodine and phosphorus.

Both treatments were prepared daily, being divided into two rations (morning and afternoon), supplied at a rate of 3% of live weight [13], and offered *ad libitum* during the 64 d of the experiment. The food consumption was determined by using the difference between the food initially offered and the rest at the end of each day. The records of feeding were taken daily and twice a month for the calve weight.

Data were processed using the SPSS version 10 statistical package with mean difference analysis, using a *t*-test for independent samples with significance level of 5%.

3. Results and Discussion

3.1 Nutritional Values of the *Guazuma* Leaf

The bromatological composition of the *Guazuma* leaf (Table 4) was 17.12% of CP. This result is similar to nutritional value reported by Rojas-Hernández [14]

Table 3 Chemical composition of the *G. ulmifolia* leaves.

Chemical composition	Content (%)
Protein	17.12
Dry matter (DM)	33.88
Crude fiber	25.79
Crude ash	6.64

Table 4 Centesimal composition and CP content of food ration based on *G. ulmifolia* leaves (T_2).

Ingredient	Weight (kg)	CP (%)	Total CP (%)
<i>Guazuma</i>	60	17.12	10.27
Rolled corn	12	12.00	1.44
Ground sorghum	9	12.00	1.08
Oats in grain	7	13.00	0.91
Wheat bran	9	11.00	0.99
Vitamins and minerals	3	-	-
Total	100		14.69

Table 5 Nutritional composition of diets based on commercial forage (T₁) and *G. ulmifolia* forage (T₂) fed to growing calves.

Nutritional composition	Commercial forage (T ₁)	Forage based on <i>G. ulmifolia</i> (T ₂)
Crude protein (%)	15.18	14.69
Ether extract (%)	19.99	8.00
Nitrogen free extract (%)	55.93	57.68
Crude ash (%)	13.33	20.00
Crude fiber (%)	4.43	19.90
TND (%)	99.97	72.23

Table 6 Weight gain of calves fed with commercial forage (T₁) and forage supplemented with *G. ulmifolia* (T₂).

Indicator	T ₁	T ₂
Initial average weight (kg)	266.33	259.33
Final average weight (kg)	340.02	356.66*
Average weight gain/animal (kg)	73.67	97.33*
Weight gain/d (kg)	1.15	1.52*
Feed consumption/animal/d (kg)	24.00	55.00*

* Results of *t*-test with $p < 0.05$.

(16.7% of CP). This demonstrated that the values obtained for the *Guazuma*-based supplement with 14.6% CP complied with the nutritional recommendations indicated by the National Research Council [13] with 10%-17% CP and 72.23% of TDN for calves kept in stables of live weight between 200 kg and 359 kg.

3.2 Daily Weight Gain of Growing Calves

The experimental rations used in the present study (Table 5) contained different levels of CP that led to varied response in the calve performance, depending on treatment; this is observed in Table 6, where T₂ showed higher values of final average weight, average weight gain, daily weight gain and feed consumption.

The productive performance of animals in the different treatments had significant differences ($p < 0.05$), for T₁ had 1.15 kg daily weight gain and 1.52 kg for T₂. These differences were due to the nutritional contribution and the effect that the inclusion of *Guazuma* as a protein source had on the diet of stabled calves, on the consumption of food and gain in live weight. Notably, the animals that received the commercial supplement with 15% CP had a lower weight gain compared to treatments supplemented with vegetable protein, which showed a significantly higher response ($p \leq 0.05$).

Palatability of food plays a role in ruminant voluntary feed intake. Chemical changes occurring in food drastically alter taste, odor and resistance and consequently decreasing food consumption [15, 16]. It was shown that voluntary consumption (Table 6) might be the main influence on ruminant weight gain, as greater palatability was observed for food elaborated with *Guazuma* leaf (55 kg), evident in the response to the two treatments; T₂ responded best and greater weight gain was observed compared to T₁. This effect may have been due to palatability and other compounds present in the food, which suggests that the administration of a diet rich in vegetable protein promotes an increase in the weight of animals that receive this.

Voluntary consumption depends on several factors, including palatability, which is the set of characteristics of the plant that stimulate the animal to consume it [17]. The content of some compounds can increase or reduce the animal's taste for particular forage. A well-known example is that the content of tannins can decrease the palatability of fodder [18], although, at low concentrations, it could improve the use of proteins. *G. ulmifolia* contains 7% tannin (Quebracho equivalents) [19], which is a moderate amount of this compound. The consumption of tannin-rich pasture in an amount less than 25% DM of

the diet would not represent a nutritional problem [20]. The toxic effect of tannin depends on the plant's concentration and the amount of this in the fodder [21].

Calves may show an innate preference for some foods that may not even have an adequate balance of nutrients [16]. Thus, both palatability and nutritive content must be considered when designing an appropriate diet. It was reported that the calves prefer high energy and high protein foods, which are also considered high palatability. This choice was maintained in the animals even when the ingredients were used in a mixture up to 50% of the content [22].

The superiority observed in terms of weight gain among calves fed with *Guazuma* was also influenced by an adequate nutritional contribution derived from food based on the *Guazuma* leaf, formulated to cover the nutritional requirements of calves at this growth stage [13]. This concurs with that reported by Acero Maldonado [23], who recognizes that daily production per animal is determined by a combination of effects that include availability and quality of the food (energy supplementation-protein), as well as appetite and the genetic potential of the animal.

4. Conclusions

The incorporation of the *Guazuma* leaf to the diet of growing calves improved the intake of the forage; a significant increment was also observed in the daily weight gain. Use of the *Guazuma* leaf in the diet of the ruminants offers an alternative for cattle production because of the nutritional contribution it makes to the animal's diet. Within strategic supplementation, *Guazuma*-based food constitutes a strategy for confining ruminants, not only during periods of dry season, but also as a back-up to supply essential nutrients, as it can improve efficiency for utilizing native forage trees during periods of relative abundance. Its easy acquisition makes this a practice that can be easily adopted by producers in the tropical region.

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