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White Mulberry (*Morus alba*) Foliage as a Feeding Supplement for Growing Calves

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Abstract: The aim of this study was to evaluate the feed consumption and weight gain in calves fed with a nutritional block made of white mulberry (*Morus alba*) for a 90-day-period, involving dry season months (March-May) in Tuxpan, Veracruz, Mexico. A total of 45 growing Zebu × Swiss calves with an average weight of 200 kg were assigned randomly in three groups of 15 animals, and the following treatments of nutritional block were offered to each group: grazing animals (T_0), grazing animals plus nutritious block with white mulberry (T_1), and grazing animals plus nutritious block without white mulberry (T_2). A consumption of 0.545 kg/d from block in treatment T_1 was observed, significantly improving calves growing and showing a weight gain of 0.933 kg/d. Use of white mulberry in nutritional blocks is a good alternative for growing calves, as a feeding strategy given the seasonality of pasture production in the tropics.

Key words: White mulberry, nutritional supplement, calves.

1. Introduction

In most of tropical regions, there is a need of a dietary supplement for cattle, considering that the rainy season is for a few months a year. This concerns the availability of forage and therefore animal production [1]. The periods for dietary supplements vary due to climate conditions each year, but usually they begin in January and end in May or June in North latitude [2]. Arboreal forage production has been widely studied, primarily as a dietary complement for ruminants [3-7]. Several species of trees that are common in tropical areas have good protein content in their foliage, thus their nutritious value can be superior to grass; in addition, they are resistant to dry season [8].

From research carried out in the last decades, principally in the agronomic field and animal production, there has been generated enough information about white mulberry (*Morus alba*) [9] that can be applied for its propagation and exploitation in a field level; so it can represent a forage strategy to animal production systems in the tropic [3, 6, 9, 10].

White mulberry production represents a profitable option for producers in bovine feeding due to its low cost, high adaptability, high forage production and appropriate nutritious levels [9]. Also, the high consumption of this plant by the animals and the excellent organoleptic characteristics make the white mulberry easy to use in protein banks and nutritional blocks as an option for ruminants feeding [4, 11].

Research of dietary supplements has been mainly directed to the use of nutritional ingredients that establish a better ruminal function, leading a balance in the degradation of fibrous nourishment and nutrient and energy intake [4, 9]. White mulberry forage has been shown to have an elevated digest index (90%), which imply the effectiveness of this plant as a supplement [3, 9, 12].

In this study, white mulberry forage has been added as an ingredient in a nutritional block and evaluated on the weight gain of growing calves, to be implemented as a common ingredient to producers on the North zone of Veracruz, Mexico.

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2. Materials and Methods

The study was conducted on the North of the state of Veracruz, Mexico, in Tuxpan city (20°57′46″ North latitude and 97°24′01″ West longitude and altitude 10 m). The average ambient temperature was 24 °C. For a period of 90 d, which covered the dry season (March to May), when shortage of forage occurs, 45 Zebu × Swiss growing calves (average weight of 200 kg) were randomly organized into three groups of 15 animals, and each group was fed according to the next treatments: grazing animals without nutritional block (T_0), grazing animals plus a nutritious block with white mulberry (T_1) and grazing animals plus a nutritious block without white mulberry (T_2).

Blocks production procedure was made in four successive and continuous phases: raw material preparation, mixing, compression and drying [13, 14]. The white mulberry (*Morus alba*) leaves and stems, grounded corn, liquid molasses, tedded pasture, calcium oxide and mineral salts were used in ration formulation (Table 1).

Average percentage of pasture bromatological composition (Table 2) and percent composition of nutritional blocks (Table 3) were determined in the Bromatology Laboratory in the School of Biological and Agricultural Sciences from University of Veracruz. Dry matter (DM), crude protein (CP), ether extract (EE), crude ash (CA), crude fiber (CF), nitrogen free extract (NFE), total digestible nutrients (TDN) and metabolizable energy (ME) were estimated by conventional methods [15].

Before the beginning of the experiment, calves were given vitamins, mineral salts and water, de-wormed and vaccinated. The animals rotate in a 20 ha extension, divided in three equal pasturelands established with Bermuda grass (*Cynodon dactylon*), giant star grass (*Cynodon pleystostachyus*) and seashore paspalum *(Paspalum vaginatum*), with a rotational intensive system for 21 d.

Throughout the study, the percentage of animals that bites or licks the fodder was monitored in the groups T_1 and T_2, in which a nutritional block was offered. Average block consumption per animal was estimated every 5 d for treatment T_1 and T_2 according to National Research Council (NRC) specifications [16].

Data was processed in a statistical package SPSS

Table 1 Composition of nutritional blocks.

Ingredients	Percent (%)	
	T_1	T_2
White mulberry (*Morus alba*) leaves and stems	80	0
Ground corn	4	65
Liquid molasses	6	6
Tedded pasture	4	23
Calcium oxide	3	3
Pre-mix vitamins and minerals	3	3

Table 2 Average bromatological composition (%) of pasture.

Composition	Bermuda grass (*Cynodon dactylon*)	Giant star grass (*Cynodon pleystostachyus*)	Seashore paspalum (*Paspalum vaginatum*)
Dry matter	91.82%	94.26%	90.82%
Crude protein	5.10%	5.30%	5.00%
Ether extract	2.12%	1.34%	1.12%
Crude ash	4.22%	5.70%	6.50%
Crude fiber	32.00%	34.10%	31.40%
Nitrogen free extract	33.40%	37.75%	30.45%
Total digestible nutrients	45.03%	41.70%	41.50%
Metabolizable energy	12.97 kJ/kg	10.88 kJ/kg	12.55 kJ/kg

Table 3 Nutritious analyses of nutritional block[1].

Composition	Quantified values	
	T_1	T_2
Dry matter	96.12%	94.10%
Crude protein	18.35%	10.43%
Ether extract	1.66%	2.22%
Crude ash	21.69%	22.34%
Crude fiber	13.58%	16.43%
Nitrogen free extract	54.33%	62.26%
Total digestible nutrients	73.38%	73.64%
Metabolizable energy	12.59 kJ/kg	13.05 kJ/kg

[1] Blocks were not prepared as isonitrogenous.

Table 4 Weight gain in supplemented calves with white mulberry(*Morus alba*) during 90 d.

Indicator	T_0	T_1	T_2
Initial average weight (kg)	200	210	212
Final average weight (kg)	270[a]	294[b]	290[b]
Average weight gain/animal (kg)	70[a]	84[b]	78[b]
Weight gain/day (kg)	0.777[a]	0.933[b]	0.866[b]
Block consumption/animal/day (kg)	-	0.545[b]	0.510[b]

Different letters in a row indicate significant differences ($P \leq 0.05$).

version 10 by one-way analysis of variance (one-way ANOVA) and the differences between treatments were detected by Duncan's test. The significance level was 0.05.

3. Results and Discussion

The crude protein content of grass (*Cynodon dactylon* and *Cynodon pleystostachyus*) consumed by the calves during the period of study varied between 5.0% and 5.3% (Table 2). Diets with low crude protein forage (8% to 10%) can be a factor to decrease voluntary consumption [17]. This nutrient fraction limits the adequate feed conversion. Therefore, calves from T_0 treatment, in addition to having low availability of forage, consumed grass of poor nutritional quality, which was reflected in a small increase in daily weight gain (Table 4).

The crude protein content of nutritional block with white mulberry forage was determined as 18.35%. The crude protein value in leaves can vary according to the age of the sprout from 21.9% to 25.6%, and stem from 7% to 11.25%, with a digestibility of over 80% [3].

The cattle presented an increase in weight gain ($P < 0.05$), when had a supplementation based on nutritional blocks with adequate crude protein values (Table 4) in comparison with the just pasture group (T_0), with an average daily weight gain of 0.933 kg for T_1 and 0.866 kg for T_2, respectively. Weight gain observed were similar to the ones obtained with highly fertilized grass and diets of agro industries sub products [16].

By the other hand, facing forage shortage, the supplement does not replace forage, but it provides an increased consumption of protein and energetic nutrients. This is explained because facing a lower availability of forage, the animal tend to cover its requirements increasing the block consumption.

Regarding total consumption of the blocks (Table 4), there was an average daily consumption by animal of 0.528 kg, this being similar to that reported previously in Refs. [6, 7].

It was not observed any difference ($P < 0.05$) in consumption of the block between treatment T_1 with white mulberry (0.545 kg/animal/day) and T_2 without white mulberry (0.510 kg/animal/day). Block

consumption based on white mulberry forage was larger than that reported by Vu et al. [18], who found a consumption of 0.568 kg/animal/day, when adding 15% of white mulberry leaves to growing cattle's diet. Nutritional blocks constitute an alternate strategy of nutritious supplements to ruminants, and besides, it can be easily produced using the raw material from the region [19]. White mulberry consumption can help to have a better balance in carbohydrates and nitrogen compounds in rumen [11] and can improve digestion and the rumen's fermentation [4].

Supplemented nourishment consumption can be very variable. The causes of this variability are related with several factors among others, such as, the characteristics of used ingredients, toughness, humidity, etc. [20]. In this work, it has been observed that molasses affected the nutritional block's consistency, leading very tough blocks (avoiding to be consumed by animals). The best results were presented when the inclusion percentage of molasses was 6% (Table 1), obtaining blocks with high softness, compressed form and palatability for calves. Considering the way that nutritional block was consumed by animal, it was found that 81.6% of them bit the block, meanwhile the 18.4% licked it. This is why toughness is fundamental to avoid over-consumption. Fabrication process of the nutritional blocks can impact directly in its toughness, which can affect consumption [20] and weight gain in calves of low pasture.

4. Conclusions

White mulberry constitutes a possibility for grazing ruminants, not just during the restriction forage periods but also as a support to supply fundamental nutritious elements that can improve efficiency in native forages consumption during relative abundance periods. Nutritious block consumption with white mulberry can guarantee the contribution of strategic elements for ruminal function and reach an adequate weight gain. It is easy to make it an alternative that can be adopted easily by producers in tropic region. Nevertheless, there has to be more researches, with the objective of increasing nourishment consumption and improving weight gain in pasture ruminants.

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