

Effect of Halophyte *Salicornia bigelovii* (Torr.) as Animal Supplement in Goat in Sonora Desert, Mexico

Research Article

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ABSTRACT

In the northwest of Mexico, a desert zone, new alternatives are required to satisfy the needs of food in goats; evidence indicate that feeding with *Salicornia bigelovii* forage, could be a contribution to goat obtaining system. Regarding to this halophyte, the information related to its use as a forage supplement in Sonora desert is very limited, specifically in goats. The goal of this study consist to analyze to *Salicornia bigelovii* about nutritional composition as a forage in pregnant goats, evaluating the weight of goat kids at birth, their average weight gain daily, the weight at weaning, as well as milk production goats from mothers. The diet was based on Salicornia and Alfalfa (Treatment 1: fully fed (100% *Salicornia bigelovii*) (96% dry matter, 14% crude protein, 17% crude fiber and 45% nitrogen-free extract). Treatment 2: fed totally (100%) with alfalfa (90% dry matter, 18% crude protein, 24% crude fiber and 52% nitrogen-free extract), 20 experimental units per treatment were analyzed. The daily dry matter provided to each experimental unit (dry matter/goat/daily) was 600 g. The results indicate that hay-based forage of *Salicornia* can used as a forage ingredient, but is not essential in Creole goat's diet, since it benefited positively the growth of goat kids and milk production. It is important to carry out evaluations with the halophyte *Salicornia* in different variables of obtaining goats, by using diets based on other forage species alternatives such as salty grass and coquia, among and other native species.

KEY WORDS arid zones, forage, goat, halophyte, *Salicornia*.

INTRODUCTION

Sonoraisa Mexican state characterized by potential capacity for agricultural exploitation. However, due to its climatology and diminutive availability of water, it results in a problem for quality and quantity production of foods for humans and forage to livestock. The annual growth in human population in Sonora Mexico is above 5%. This, it is necessary to emphasize on search production alternatives to meet the growing needs; activities that have to be evaluated

and including into the animal sector (Ghadami *et al.* 2019). In livestock sector developed in rural area of Sonora, goat farming is the one important economic activity. The main purpose is the production of meat and milk. The total population goats in Sonora (1,116, 443 heads) is majority concentrated in the next communities: Obregon, Navojoa, Hermosillo, Magdalena de kino and Puerto Peñasco; given it, is necessary to get new alternatives to need satisfies of goat production, there is evidence that the feeding could be with *Salicornia bigelovii* forage in a good proportion and

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thus may contribute to goat production system (Pandey, 1990). Cattle feeding is a common problem in general livestock; according with feeding goats, is based on the forage provided by the natural pastures and these in turn depend on rainfall, and under desert conditions there isn't increase on goat inventory; so the incorporation of supplementation foods in foods programs with halotolerant forages is very important. The halophyte *Salicornia bigelovii*, develops naturally on coastal Sonora State. The agro-industrial importance of this halotolerant resides falls in capacity of food productions for human consumption essentially salads, flours and fodder production. In addition, being an edible *Chenopodaceae*, it has singular importance as a source of protein, indispensable for the animal feedings. *Salicornia* currently has an interest to be study as an agro-industrial crop; in relation to obtained information such as forage supplement in Sonora desert, very little information is available, in goats specifically. For this reason, this study proposes to evaluate *Salicornia bigelovii* about nutritional composition of forage, to analyze to *Salicornia bigelovii* about nutritional composition as a forage in pregnant goats, evaluating the weight of goat kids at birth, their average weight gain daily, the weight at weaning, as well as milk production goats from mothers. The hypothesis arises in research proposal is that *Salicornia bigelovii* use in a forage supplement on creole goats and evaluating different variable productions, effect is going to be significant.

MATERIALS AND METHODS

Study area

The present study was conducted in a rural production area of Puerto Peñasco, Sonora located in southern portion at 24° 08' north latitude and 110° 24' west longitude. According to Köppen formula modified by García-De Miranda (1981), Puerto Peñasco, Sonora, has a BWhw (x') (e') climate type, it's very dry (semi-warm), low rain during October to December months; average annual precipitation by 60.1 mm; and annual average temperature at 21.2 °C. The maximum temperature in the months of March, June, September and December is 26.7 °C, 32.3 °C, 35.1 °C and 22.9 °C, respectively.

Collection and bromatological analysis of *Salicornia bigelovii* and *Medicago sativa*

Salicornia bigelovii vegetative material in material in flowering stage, was collected from a natural area located at Latitude 28° 40' 35.24" N, Longitude 111° 55' 44.21" W, at a height between 2 and 10 m, in Puerto Peñasco, Sonora. The height of plants was 40 ± 5 cm. The samples were placed in paper bags duly labeled and transferred to Laboratory of bromatological analysis. The samples of biomass (complete plant, stem and leaf) were dried, ground and

taken to the bromatology laboratory in Sonora University, where by means of conventional laboratory techniques (proximal analysis), determinations was: 1) humidity percentage, 2) protein percentage, 3) crude fiber percentage, 4) lipids percentage, 5) ashes percentage, 6) free-extract nitrogen percentage, and 7) energy (calories/g) (Ávila Serrano, 2006). Likewise, plants from an agricultural field were collected, planted with alfalfa in pre-flowering stage. The samples were deposited in paper bags; were labeled and transferred to bromatology laboratory. Analyzes performed were similar to those previously reported for *S. bigelovii*.

Study animals

Twenty adult goats (nine-months age) were used in experiment, with homogeneous characteristics such as breed (creoles), weight 28 ± 2 kg, and calving date (birth November=previous year=AA), of which were placed in gestation in august month (later year=AP). To homogenize the heat and its subsequent insemination, the goats were stimulated by progestogen uses on sponge forms, and this were add in the vagina for 16 ± 3 days, combined with an intramuscular PMSG injection hormone (Equine Coronary Gonadotropin=eCG or PMSG=) that stimulates ovulation. At 30 hours, sponges were removed, to wait for estrus and ovulation.

The artificially collected semen, which was donated by the company "Mena Capri", of Cuautla, Morelos, was deposited on reproductive tract of female's goats to produce the fertilization of mature ovules. Subsequently, delivery was expected three months later (November AA), to evaluate the number of kids, which were evaluated at birth and at weaning two months after birth. The feeding experienced animals was based on *Salicornia* and alfalfa (T1=totally fed (100% of *Salicornia bigelovii*) (96% of dry matter, 14% of crude protein, 17% of raw fiber and 45% of nitrogen-free extract T2= totally fed (100%) with alfalfa hay (90% dry matter, 18% crude protein, 24% crude fiber and 52% nitrogen-free extract), seven experimental units per treatment were analyzed. The dry matter daily provided to each experimental unit (dry matter/goat/daily) was 600 g.

Experimental design

The experimental design was completely randomized. Analysis of variance, and multiple mean comparison (Tukey P=0.05) were performed.

Study variables

Variables measured in experiment were; weight kids (young goats) at birth and every week until weaning, calf sex, weight daily, parturition type and milk production, were measured every third day by manual milking (1 time/day) during the second month of lactation (after weaning). Analyzes were developed into the laboratory.

RESULTS AND DISCUSSION

According to proposed methodology, results obtained corresponding to forage quality of *Salicornia bigelovii*, chemical proximal analysis and energy analysis are presented in Table 1. The crude protein content in *Salicornia bigelovii* was $13.06 \pm 0.39\%$ while for alfalfa it averaged $17.9 \pm 1.9\%$. For the proportions of total lipids it was 2.36 ± 0.30 and 0.7 ± 0.5 , in *Salicornia* and alfalfa, respectively. The value obtained for metabolizable energy (kcal/kg) was 2.890 ± 0.99 in the halophyte, while for alfalfa it was 2.744 ± 0.48 .

Glenn *et al.* (1999) and Rueda *et al.* (2004), obtained similar results for *S. bigelovii*; for alfalfa case, values coincide with Zaragoza and Pérez (2001); Villegas *et al.* (2004) and Shaver and Hoffman (2010), this latter, suggest that if recollect them in pre-flowering stage, can obtain a major quality and higher nutrition of forage.

It should be noted that meeta nutritional plan, value considered to have forage potentials represents certain additional advantages when considering the following aspects: 1) physical form in which the forage can be provided (Sanz *et al.* 1998); 2) availability; 3) preference (Coirini *et al.* 2005); 4) dry matter consumption (Galina *et al.* 1998; Lou *et al.* 2004); seasonal variation and eco-physiological characteristics, since this will allow to be used properly at right time and above all according to the nutritional-physiological requirements (Hossain *et al.* 2003; Shimada, 2003; Nsahlai *et al.* 2004a; Nsahlai *et al.* 2004b; Lou *et al.* 2004; Moore *et al.* 2004; Sahlu *et al.* 2004) of goat or exploited species.

On this experiment *Salicornia bigelovii* was evaluated as a forage supplement considering alfalfa as control, in the productive variables of pregnant goats, the results obtained indicate no obtained significant differences ($P \geq 0.05$) due to the effect of treatments for the variables evaluated as they are weight at birth, weaning weight, average daily weight gain and average daily milk production per goat during the second month of lactation (Table 2). Mellado-Bosque (1991) and Akpa *et al.* (2003), mention that the frequency of milking improves or increases milk production. With the knowledge that factors such as the type of parturition and sex of the offspring can have an influence on the response of the variables evaluated, the corresponding analysis was recorded and performed, in which no statistical differences were found due to the sex effect of the breeding ($P \geq 0.05$) (Table 3).

Studies related to forage supplements based on yorimon beans, coincide with the present study, the same variables evaluated didn't observed significant differences (Ávila Serrano, 2006); however, this author found significant difference in variable "type of delivery" between single and double births; variable that was not considered in the present study. Likewise, it has been observed that the goat under grazing conditions, freely selects its diet and quality of the forage consumed is superior to that of forage offered and therefore is more in line with satisfying its requirements. This is more evident in natural pastures where number of existing species is abundant, evaluating natural species, found differences in the crude protein contents between the species and the phenological stage, contrasting vs this study in digestibility tests (Hidalgo *et al.* 1998).

Table 1 Nutritional content of *Salicornia bigelovii* and alfalfa (*Medicago sativa*), from Puerto Peñasco, Sonora

Composition	<i>Salicornia bigelovii</i> average (%)	Alfalfa average (%)
Humidity	80.56±3.2	78.88±3.4
Dry matter	17.55±2.1	22.34±3.6
Protein	13.06±0.39	17.9±1.9
Acid detergent fiber	28.4±0.38	37.6±1.3
Neutral detergent fiber	54.1±0.60	49.5±3.9
Lipid	2.36±0.30	0.7±0.5
Lignin	5.6±0.9	10.6±1.3
Metabolizable energy (kcal/kg)	2890±0.99	2744±0.48
Ashes (%)	0.5±0.4	0.18±0.8
Calcium (%)	1.5±0.9	1.30±0.7

¹ The values correspond to the average of three repetitions.

Table 2 Effect of hay and chopped forage of *Salicornia bigelovii* and alfalfa (*Medicago sativa*) on variables weight at birth, weight gain of kids daily average, weight of kids at weaning, as well as milk production in goats

Variable	Forage type	
	<i>Salicornia bigelovii</i>	Alfalfa (<i>Medicago sativa</i>)
Weight at birth (kg)	2.673±0.425 ^a	2.993±0.250 ^a
Days at weaning	57±4.00	57±4.00
Weaning weight (kg)	8.99±1.89 ^a	10.21±1.99 ^a
Daily weight gain (g)	115.88±19.23 ^a	132.88±20.12 ^a
Average milk production (mL)	734.99±146.23 ^a	621±189.20 ^a

The means within the same row with at least one common letter, do not have significant difference ($P > 0.05$).

Table 3 Sex effect of breeding on birth weight, weight gain of average daily kids, weight of weaning kids, fed with forage hay and chopped of *Salicornia bigelovii* and *Medicago sativa*

Variable	Male	Female
Weight at birth (kg)	3.17±0.232 ^a	2.783±0.367 ^a
Days at weaning	57±4.00	57±4.00
Weaning weight (kg)	10.43±1.09 ^a	9.01±1.23 ^a
Daily weight gain (g)	138.78±13.33 ^a	145.78±12.23 ^a

The means within the same row with at least one common letter, do not have significant difference (P>0.05).

"*In vitro*" of dry matter and being richer and digestible in the initial phenological state with respect to the advanced. The results of the present study coincide with those obtained by Faftine *et al.* (1998) and Ávila Serrano (2006) in other hand, weight gain and yield, using in feed of goats forage of beans yorimon and another study by Adeloye (1995) this author mentions that there were appropriate consumption of dry matter, good feed conversion and high nutritional value (protein content).

Other actions to increase the quality in milk was carried out by Koushki *et al.* (2019).

CONCLUSION

The results obtained from present investigation conclude that: the forage based on *Salicornia* hay can be used as a forage ingredient but is not essential in diet of creole goats, since it positively benefited the growth of the kids and the production of milk. It is recommended to carry out more evaluations on the halophyte *Salicornia bigelovii* in goat production variables, by using diets based on other alternative forage species such as salted grass, fodder cactus, coconut, among other native species.

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