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### Effects of maturity and ensiling of *Agave salmiana* on nutritional quality for lambs

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#### ABSTRACT

The objectives of this study were to evaluate the chemical composition, intake, N balance, total tract digestion and ruminal disappearance of dry matter (DM) and neutral detergent fiber (NDF) of *Agave salmiana* harvested when young or mature and fed either fresh or as silage to lambs. The experimental design was a 4 × 4 Latin square with a factorial (2 × 2) arrangement of treatments: (a) process = fresh or silage; (b) agave age = young (12 years) or mature (16 years and sterilized). Young agave had a higher organic matter (OM) and lower crude protein (CP) and saponin concentrations than mature. Ensiling decreased soluble carbohydrates (SC), saponin concentrations, and pH. Dry matter and OM intakes of agave fresh were lower than others. Saponin intake was lower with agave silage than fresh. Total tract digestion was not altered by treatments. The highest nitrogen retention value was found in lambs fed mature agave as silage. Both ruminal disappearance of the insoluble fraction and disappearance rate of DM and NDF for young were higher than for mature agave. Ruminal molar proportion of propionate was higher and acetate:propionate ratio was lower in lambs fed agave silage than fresh. Lambs fed young agave had lower ciliate protozoa numbers than those fed mature agave. Ensiling agave increased NDF disappearance, ruminal fermentation and N balance in lambs.

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**Abbreviations:** DM, dry matter; OM, organic matter; CP, crude protein; NDF, neutral detergent fiber; SC, soluble carbohydrates; VFA, volatile fatty acids.

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## 1. Introduction

In the arid and semiarid areas of northern Mexico, over-grazing of the native vegetation together with lengthening drought periods have decreased feed availability for animals causing serious problems for small farmers who raise goats, sheep and cattle. Certain species of plants are well adapted to those unfavorable environment conditions and can be used as feed for livestock. Agaveceas are an example of those well adapted plants, although, they have low nutritional value and anti-nutritional factors such as saponins. This may have either a positive or negative impact on ruminal function (Francis et al., 2002), and calcium oxalate crystals that together with saponins cause skin irritation of animals and farmers who harvest such plants (Franceschi and Nakata, 2005). *Agave salmiana* is commonly found in the semiarid region of north-central Mexico; compared with other wild agaves, it has more massive leaves with a much larger surface area, and a productivity about 10-fold higher than that for desert ecosystems (Nobel and Meyer, 1985). Heads of mature *A. salmiana* are collected year round to produce “mezcal” (a distilled drink). Tequila is a mezcal from one specific region of México. When roughage is scarce, this plant is used as a fresh feed for ruminants. Pinos-Rodríguez et al. (2006) and Silos-Espino et al. (2007) characterized this agave as acceptable forage with a high content of soluble carbohydrates (SC) and moisture, but low in protein. Regardless, there is a paucity of nutritional studies about agaves. The objectives of this study were to evaluate the chemical composition, intake, N balance, total tract digestion and ruminal disappearance of dry matter (DM) and neutral detergent fiber (NDF) of *A. salmiana* harvested when young or mature and fed either fresh or as silage to lambs.

## 2. Material and methods

This experiment was conducted under the supervision and with the approval of the Academic Committee of the Instituto de Investigación de Zonas Desérticas, Universidad Autónoma de San Luis Potosí, according to regulations established by the Animal Protection Law enacted by the San Luis Potosí (S.L.P.) State in Mexico.

### 2.1. Design and animals

The experimental design was a 4 × 4 Latin square with a factorial arrangement (2 × 2) of treatments, agave processing (fresh or ensiled) and plant age (young or mature) were the principal factors. Treatments were assigned randomly to four Rambouillet lambs (42 ± 5 kg body weight) fitted with ruminal cannulas. Lambs were housed in metabolism pens equipped with a mesh for feces separation and plastic bucket for urine collection.

### 2.2. Study site and plant material

Wild plants of *A. salmiana* (Otto ex. Salm Dyck) were collected from Ipiña, Ahualulco, S.L.P., in central Mexico. The site has an arid climate, an altitude of 1887 m, an annual temperature average of 16.8 °C, an annual rainfall average 389 mm with most of the precipitation between September and November and a marked dry season in the spring. Agave plants were harvested at an early (12 years old) or mature (16-year-old) stage of growth. The latter plants had been rendered sterile 12 months earlier by withdrawing the floral peduncle or yolk from the plant before reproduction took place. From young and mature agaves, 1000 kg were chopped (20 mm) with a forage harvester (Azteca, Aguascalientes, Mexico) and ensiled in 10 plastic silos (capacity 200 l). The silos were compacted with a manual press and stored outdoors (13–32 °C) for fermentation for 90 days. Every 2 weeks, young and mature agave plants were obtained from the same place. Fresh plants were kept in a natural ventilated room averaging 20 °C.

### 2.3. Digestibility assay

Digestibility was measured in a trial which included 7 days for adaptation to diets followed by 5 days for sample collection and 5 days for *in situ* incubations and collection of ruminal liquid for measuring

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