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Short communication

Effects of species and maturity stage on nutritional and fermentation characteristics of *Sarcobatus* species

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ABSTRACT

The aim of this paper was to investigate the effect of maturity stage and species on nutritional and rumen fermentation characteristics of two species of greasewood, Black [*Sarcobatus vermiculatus* (Hook) Torr], and Bailey [*Sarcobatus baileyi* (Coville) Jepson]. Crude protein (CP) content of both species for all stages ranged from 114.1 to 204.8 g/kg, which is greater than the maintenance requirement of cattle. Highest CP content (204.8 g/kg, $P = 0.045$) was observed for Black greasewood pre-bloom. Highest acid detergent fiber (ADF) and lignin (sa) fractions (311.3 and 103.9 g/kg, $P < 0.05$, respectively) were recorded for Bailey post-bloom, while the lowest ADF and Lignin (sa) fractions (163.4 g/kg and 36.3 g/kg, $P < 0.05$, respectively) were obtained for Black greasewood pre-bloom stage. In vitro dry matter (IVDMD) and organic matter (IVOMD) disappearance, ammonia nitrogen (NH_3N), and volatile fatty acid (VFA) content were determined at the end of a 48 h incubation period. Black greasewood was higher (409.0 vs. 366.1 g/kg; $P = 0.006$) in IVOMD than Bailey greasewood. The pre-bloom stage yielded more ($P = 0.015$) IVOMD than the bloom and post-bloom stages. No IVOMD difference was observed between bloom and post-bloom stages. Rumen ammonia nitrogen was highest (32.13 mg/100 ml; $P = 0.005$) for Black greasewood pre-bloom. Total VFA was significantly affected by species and maturity. The highest total VFA content was observed for both species pre-bloom. Total VFA remained the same for Black greasewood at bloom and post-bloom stages, while it declined significantly with increased maturity for Bailey. Based on this study Black greasewood has greater potential than Bailey greasewood as a late summer and early fall forage source in salt desert shrub plant communities of the Great Basin.

1. Introduction

Native forages with inherently high protein content can be important forages for rangeland animal agriculture operations (wild ungulates as well) in the Great Basin and other areas of western Northern America. Two species of greasewood, Black [*Sarcobatus vermiculatus* (Hook) Torr.], and Bailey [*Sarcobatus baileyi* (Cov.) Jeps.], occur in the Great Basin. The former is distributed throughout the region on alkaline or saline floodplains with relatively high water tables, often functioning as

Abbreviations: ADF, acid detergent fiber (inclusive of residual ash); Lignin (sa), lignin determined by solubilization of cellulose with sulphuric acid; CP, crude protein; DM, dry matter; IVDMD, in vitro dry matter digestibility; IVOMD, in vitro organic matter digestibility; aNDF, neutral detergent fiber assayed with heat stable amylase and expressed with residual ash; OM, organic matter; NH_3N, ammonia nitrogen; VFA, volatile fatty acid.

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a phreatophyte (Perryman, 2014). Black greasewood covers over 4.8 million ha from Mexico to Canada primarily in cold deserts (Robertson, 1983). Bailey greasewood, a non-phreatic, upland form, occurs on fine to course textured soils derived from saline lake sediments along the east face of the Sierra Mountains, covering approximately 0.2 of western Nevada and eastern California (Robertson, 1983).

Black greasewood has been recognized as a palatable rangeland forage known for its oxalate toxicity potential for decades (Fleming et al., 1928). It was first analyzed by Forbes and Skinner (1903) to determine nutritional content by proximate analysis: crude protein (198.1 g/kg), fat (24.5 g/kg); and soluble carbohydrates (342.8 g/kg). Nutritional content suggests that Black greasewood is excellent native forage. However, Forbes and Skinner (1903) also state, "The figures quoted give no grounds for rejection of the plant for grazing purposes; yet, under actual feeding conditions, the greasewood fails to fulfill the promise given by its analysis." Although Black greasewood is recognized as excellent rangeland forage, it has been understood that under field conditions, animal performance has not matched the nutritional analysis.

Ensminger et al. (1990) reported nutritional content of greasewood including crude fiber, ash, ether extract, N-free extract, crude protein, total digestible nutrient, and digestible metabolizable and net energy for ruminants. However, these values were taken from bulk samples at one point in time, or combined across several points in time. They also list the values as *Sarcobatus* spp., indicating the mixing of greasewood species for their analysis.

Nutritional characteristics often change with maturity stage. Smith et al. (1992) demonstrated that mean crude protein levels reached 160 g/kg ranging between 210 g/kg (spring) and 140 g/kg (fall) across the growing season for Black greasewood in ephemeral stream channels of Wyoming. In order to optimize grazing animal efficiency on native rangeland forages, it is necessary to understand how nutritional characteristics change as plants mature. Additionally, nutritional characteristics of Bailey greasewood as a separate species have not been investigated since only recently the genus was formally recognized as having two distinct species (Perryman, 2014). Rumen fermentation characteristics of both species have not been investigated.

Our aim was to study the nutritional and fermentation characteristics of two greasewood species at three maturity stages: pre-bloom, bloom, and post-bloom.

2. Materials and methods

2.1. Experimental design

The chemical composition experiment was organized as a completely randomized design (CRD), arranged in a 2×3 factorial treatment structure with 30 experimental replications (individual plants), and two laboratory replicates run simultaneously. The in vitro experiment was organized identically but with laboratory replication that consisted of three incubation tubes run on each of two consecutive days. Treatments included: the two greasewood species (Black and Bailey) and three maturity stages (pre-bloom, bloom, post-bloom). Chemical composition variables included: dry matter (DM), organic matter (OM), neutral detergent fiber assayed with heat stable amylase (aNDF), acid detergent fiber inclusive of residual ash (ADF), lignin determined by solubilization of cellulose with sulfuric acid [lignin (sa)], and crude protein (CP). In vitro analysis included in vitro dry matter digestibility (IVDMD), in vitro organic matter digestibility (IVOMD), total volatile fatty acids (VFA) and individual fatty acids all measured at 48 h incubation time.

2.2. Field methods

Vegetation samples for both species were taken simultaneously in 2003. Pre-bloom samples were obtained in mid-May; bloom stage samples in early-July; and post-bloom in late-September. Samples were taken from ecological sites located approximately 25 miles northeast of Reno, Nevada. Black greasewood was sampled from a gravelly loam 4–8 precipitation zone (027XY018NV) ecological site and Bailey greasewood from a sandy 5–8 precipitation zone (027XY009NV) ecological site (NRCS, 2003) less than 100 m from the former site.

Approximately, 20 g (dry weight) of non-woody biomass were collected from 30 random plants of both greasewood species at four random locations in the upper plant canopy and combined into a single, pooled sample for each plant (80 g total per plant). The purpose of multiple canopy locations was to collect material that had a high potential for being consumed by grazing animals. The non-woody biomass included leaves, and current year vegetative and reproductive stems. Sampling also included any reproductive organs and tissues that might be present. For both species, and for each stage of maturity, samples from all 30 plants were oven dried at 55 °C for 48 h and ground to a 2 mm sieved particle size.

2.3. Laboratory methods

Chemical composition samples were analyzed for DM and ash according to methods 930.15 and 942.05 of AOAC (2000), respectively; and ADF, Lignin (sa), aNDF, according to Van Soest et al. (1991); neutral detergent fiber was assayed with heat stable alpha amylase, without sodium sulphite and expressed with residual ash. Kjeldahl nitrogen was determined using a Kjelteck 2300 analyzer unit (Foss North America, Eden Prairie, MN).

For the in vitro analysis, 0.5 g of substrate from each plant-subspecies-maturity stage was loaded into three separate 50-ml centrifuge tubes, and three corresponding blank tubes, for two separate runs (two runs $\times$ three tubes). Rumen fluid from two mature, rumen fistulated Angus steers was combined and used to inoculate fermentation tubes (Care and handling of